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DECEMBER 1960

WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

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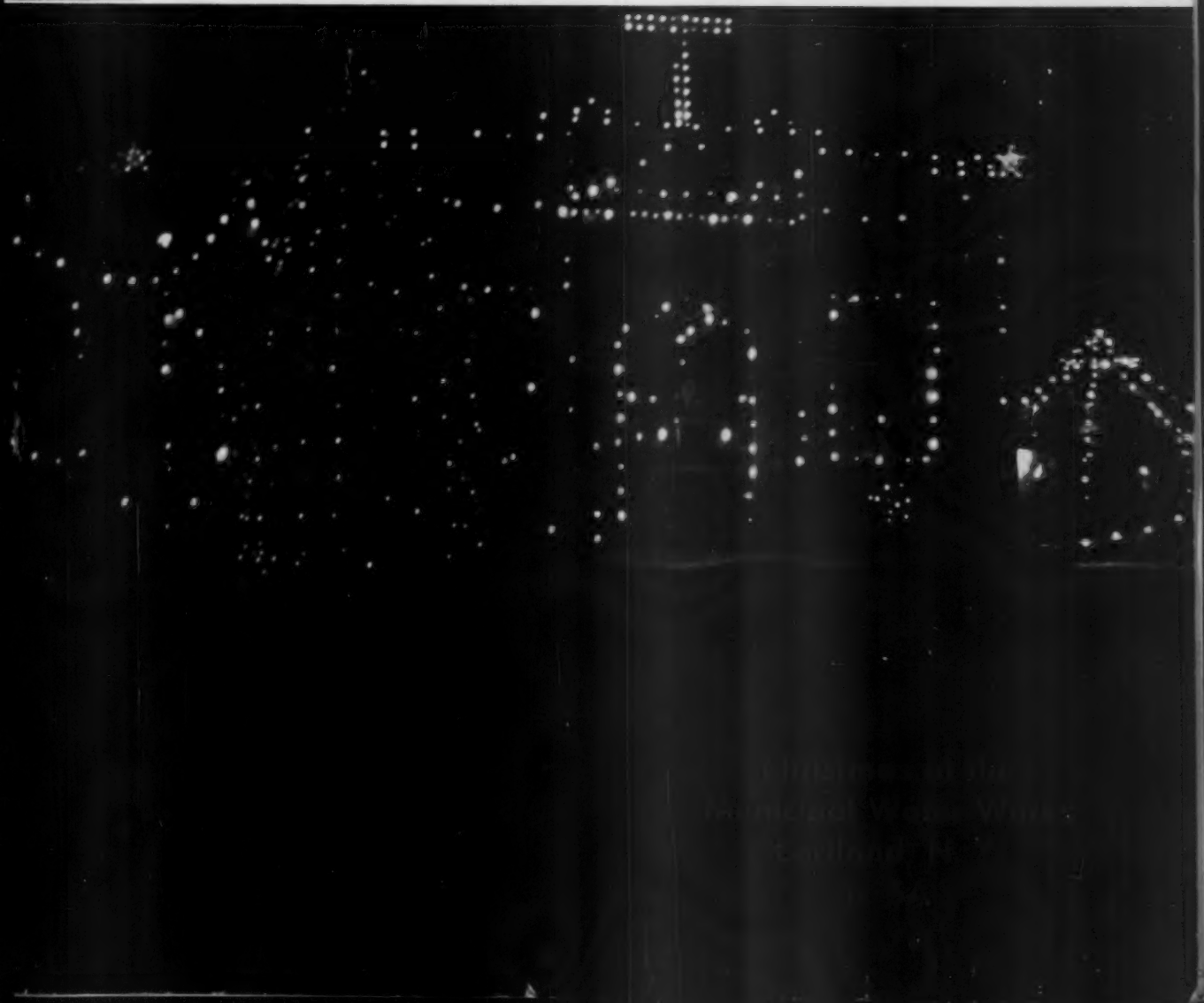

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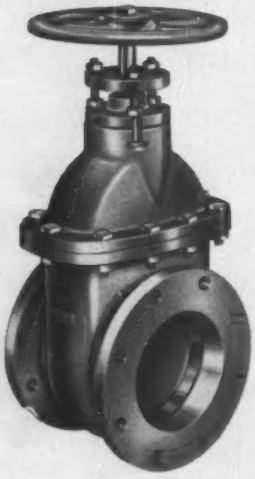
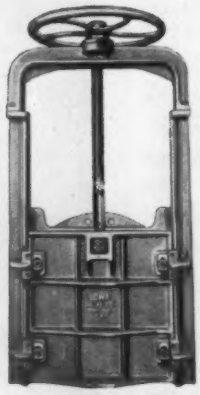


Flanged Gate Valves 2" through 42"

Flap Valves

Plug Drain Valves



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Vol. 107 No. 12
DECEMBER • 1960

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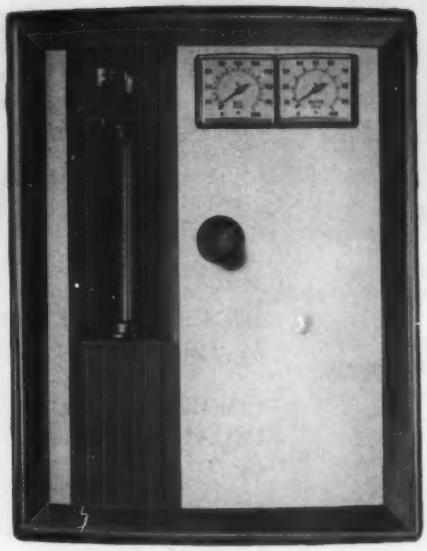

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Briefs

Digester Volume Requirements, for municipal sewage sludge stabilization, explores such topics as the capacity for sludge storage, supernatant, and actively digesting liquors—Page 453.

Colorimetric Determination of Chlorine Dioxide in water uses a new indicator, diethyl-p-phenylene diamine (DPD) to obtain enough data to calculate the amounts of free chlorine, chlorine dioxide, monochloramine and dichloramine in a mixture of materials in solution in water—Page 457.

Household Detergents in Water and Sewage—A review of the most recent research being made on this pertinent subject, such work ranging from studies of the phosphorous content of a river to the bacterial degradation of alkyl benzene sulfonate—Page 459.

Toxicity Studies on Cadmium and Hexavalent Chromium—A Research Progress Report that concerns itself principally with the small amounts of these chemicals probably present in water supplies—Page 465.

Operating Results of Valve Design illustrates how a typical manufacturer in the water and sewage works field sets up test procedures so to insure that its designs will result in successful operation of new equipment—Page 467.

Reverse Circulation Drilling—This well drilling technique can produce more water at less cost, especially from wells being drilled into glacial drift—Page 470.

Regulation For Better Water Utility Service can be provided by public service commissions. Badly needed is a better understanding of the water ultilities task of providing improved service through planning—Page 475.

Cryptic Christmas Cards is a musing (and amusing) reflection by Partially Oriented on how to use and whom to send Christmas cards *with a message*—Page 479.

Missouri Water and Sewage Technical School provides lectures, demonstrations and practice for students seeking personal professional improvements. The school helps fill the need for raising the standards of water plant operators—Page 480.

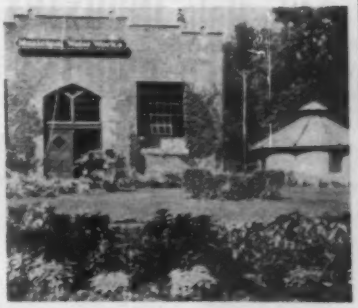
Distribution of Carbohydrate Metabolism in sewage sand filters is demonstrated by chemical radio-chemical methods. (A Research Progress Report)—Page 485.

A Suburban Community Solves a Problem by installing an aerobic digestion plant—Page 489.

Versatile Diatomite Filters, full automatic, have enabled the San Jose Water Co., Saratoga, Calif., to provide an economical means for supplying municipal water needs—Page 491.

Cool, Clear Water for Camp Lejeune outlines a water treatment plant that produces what some say is the finest drinking water on the Eastern seaboard—Page 493.

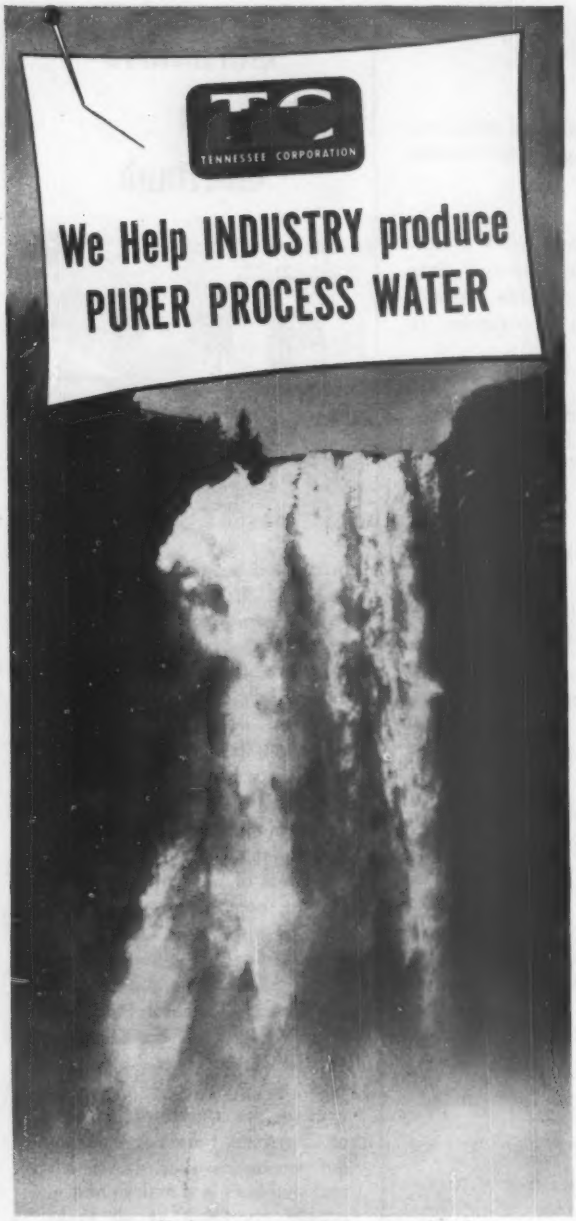
Christmas at Cortland



is marked by an added aura of joy and festiveness. Not only are its homes and stores brightly decorated for the occasion, but also, as an added attraction, and this shouldn't be a surprise, its waterworks plant lights up its main building and gaily adorns its lawn with Holiday motifs.

So picturesque is the Cortland plant at this time, that hundreds of people from neighboring communities motor in just to view the scene. Perpetuator of this good will activity toward neighbors and customers is Daniel J. Houlihan, Superintendent of the Cortland Water Board. Mr. Houlihan sees to it that the plant's grounds are attractive not only at Christmas time but throughout the entire year. The lawns and shubbery are maintained in proper condition at all times and, in addition, a small "zoo", comprised of a few species of local birds and animals, is maintained for the public. Cortland citizens visit the works frequently to see the "zoo" and the flower beds on the grounds, and to fish in an adjacent lake.

The city itself is located in the Tioughnioga River Valley in the central part of New York State and is the shipping center for an extensive farming and dairying area. The municipally-owned water system is supplied by three wells, two shallow and one deep.



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Meetings

WHAT WHEN
WHERE

1961

JANUARY						
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Dec. 12-14—Washington, D.C. (*Sheraton-Park Hotel*) NATIONAL CONFERENCE ON WATER POLLUTION. Contact Frank A. Butrico, Exec. Secy., National Conference on Water Pollution, Public Health Service, U. S. Dept. of Health, Education, and Welfare, Washington 25, D.C.

Jan. 9-20—Cincinnati, Ohio (*Robert A. Taft Sanitary Engineering Center*) Short courses on "Bio-oxidation of Industrial Wastes" and "Recent Developments in Water Bacteriology." Write: Chief, Training Program, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio, or to a PHS Regional Office Director.

Jan. 18-20—New York, N. Y. (*Park Sheraton Hotel*) N. Y. SECTION WATER POLLUTION CONTROL ASSN.

Jan. 24—New York, N. Y. (*Park Sheraton Hotel*) NEW YORK SECTION A.W.W.A. Luncheon Meeting. Secy., Kimball Blanchard, c/o Neptune Meter Co., 22-22 Jackson Ave., Long Island City 1

Jan. 31-Feb. 1—Urbana, Ill. (*University of Ill.*) THIRD SANITARY ENGINEERING CONFERENCE. Subject: Disinfection and Chemical Oxidation in Water & Waste Treatment. Write Ben B. Ewing, Assoc. Prof. of Sanitary Engineering University of Ill., Urbana, Ill.

Feb. 1-3—Indianapolis, Ind. (*Sheraton-Lincoln Hotel*) IND. SECTION A.W.W.A. Secy., Chester H. Canham, State Board of Health, 1330 W. Virginia St., Indianapolis

Mar. 10—Jackson, Mississippi (*Robert E. Lee Hotel*) MISSISSIPPI SECTION WATER POLLUTION CONTROL ASSN.

Mar. 15-17—Atlantic City, N. J. (*Traymore Hotel*) NEW JERSEY WATER POLLUTION CONTROL ASSN. Write: Charles Saunders, P. O. Box 124, Linden, N. J.

Mar. 16—Boston, Mass. (*Statler-Hilton Hotel*) NEW ENGLAND SECTION A.W.W.A. Secy., Ralph M. Soule, San. Engr., State Dept. of Public Health, Boston

Mar. 22-24—Chicago, Ill. (*LaSalle Hotel*) ILL. SECTION A.W.W.A. Secy., Dewey W. Johnson, Research Engr., Cast Iron Pipe Research Assn., 3440 Prudential Plaza, Chicago 1

News—Here & There

Michigan Consulting Firm Announced

Michigan Associates, internationally known firm of consulting engineers, with headquarters in Lansing, Mich., have announced the change in firm name to John R. Snell Engineers, Inc. Officers and principals of the firm include: John R. Snell, President; John M. Fairall, Vice President; William G. Turney, Treasurer; and William T. Harvey, Secretary.

The firm will continue to specialize in municipal and industrial engineering services, including water supply, purification and distribution, and sewage and refuse treatment and disposal.

Overseas work will continue. Recent projects include work in Korea, Argentina, Columbia and Guatemala.

Flemming's Comments on National Conference

Arthur S. Flemming, Secretary of Health, Education, and Welfare, has asked for "vigorous discussion" of water management problems when the National Conference on Water Pollution meets in Washington this month.

At a meeting of the Conference's 35-man steering committee held on August 11, Secretary Flemming told an audience of professional, industrial, and civic leaders that the Conference will have a unique opportunity at its meeting to develop views which can be placed before an incoming Congress and a new administration.

He set two goals for the Conference—that it try to obtain substantial agreement: (1) on National goals for water pollution control; and (2) on the specific programs needed to reach these goals. He noted that, at a citizen's conference, unanimity of opinion on highly controversial issues cannot be expected. "But this is a healthy democratic process," he said, "and is the way in which we make progress in this country in this issue as well as in many other issues."

German Industries Fair for Manufacturers

The United States Department of Commerce has announced that space is still available at the 1961 German Industries Fair for American exhibitors of machinery and engineering equipment.

Dr. Clauss, Director of the Foreign Trade Department of the Fair to be held in Hanover, scheduled for April 30-May 9, 1961, has advised the American Embassy that a total of 66,000 square yards of additional space will be available for the Fair, including 66,000 square yards of indoor space in three new halls, 16A, 16B and 16C, and 66,000 square yards outside space.

The added space will be devoted to only exhibits of machinery and engineering equipment. The Fair already has a large number of applications from American firms in the electrical equipment and consumer goods fields, but many cannot be accommodated for lack of space. Dr. Clauss feels exhibitors of machinery and equipment for the chemical industry can be allocated space if they file promptly.

The Fair is represented in the United States by the German American Chamber of Commerce, 666 Fifth Ave., New York 19, N. Y., and applications for space may be made to that office.

You'll Be Interested

to know that the November/December issue of our sister magazine, *Industrial Water & Wastes,* is featuring such outstanding articles as:

Flame Ionization Analyzer for Hydrocarbon Determination
Controlled Mine Water Drainage
Abstracts of Papers—7th Ontario Industrial Waste Conf.
Centrifugal Pump Series, Part IV—Rating Curves & Charts
Paper and Textile Wastes—(9th So. Municipal Conf. Report)

Kydd to Manage Palos Verdes Water Co.

Paul N. Kydd of Mill Valley, Calif. has been elected Vice President and General Manager of Palos Verdes Water Company. He will fill the management position left vacant by the death of George Kendall last June. His major responsibility will be to direct the continuing modernization and expansion of the company's facilities, required by the rapid growth of the several Palos Verdes communities served by the company.

Before making his home in Mill Valley, Mr. Kydd had a varied career in process engineering and business and sales administration, both here and in England. For many years he headed the Water Supply of Jamaica, New York, where he modernized the physical plant and reorganized its financial structure. He is the author of many studies on municipal water supply and public utility operations, and was at one time Assistant Secretary on the New York State Transit Commission, representing the Commission in its dealings with the legislature.

NAM Views on National Water Resources

In their Current Issues Series booklet No. 7, the National Association of Manufacturers presents its view on the "Wise Use of our National Water Resources". The publication is divided into four chapters entitled: "What Shall Be Our National Water Policy?"; "Are Federal Grants For Municipal Waste Water Treatment Plants Necessary?"; "Shall We Weaken The Standards For Evaluating Federal Water Projects?"; and "Official Policy Positions of the NAM Dealing with Water Resources".

The 35-page booklet is considered by the NAM to be especially timely in view of the recent deliberations of the Senate Select Committee on National Water Resources and the imminent National Conference of Water Pollution being held in Washington this month.

The position of the NAM is: that they believe each state should have

CONTINUED ON PAGE 9A

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H-15176—Mueller Copper Service Pipe Connection Inlet; Inside I.P. Thread Outlet
H-15201—Mueller Copper Service Pipe Connection Inlet and Outlet

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News—Here & There

CONTINUED FROM PAGE 7A

the right to administer the water resources within its own boundaries; that regional problems should be handled through interstate compacts; that community watershed associations are "ideal" vehicles for handling local water problems; that industry should be permitted maximum freedom in taking care of its water problems; and that there is *no* (Italics theirs) justification for granting Federal agencies "authoritarian" power over this "important natural resource".

Copies of the publication may be obtained from the Economic Problems Department of the NAM, 2 East 48th St., New York 17, N. Y., at $1.00 a copy.

Arthur T. Luce Retires

Arthur T. Luce, Vice President—Engineering, of Utilities and Industries Corp. (formerly New York Water Service Corp.) was retired October 31, 1960, after thirty-four years of service with this firm.

Mr. Luce has been a member of the AWWA since 1919 and is a past President of the New York Section. He has disclosed that he will continue work as a consultant on water works and sewage matters from his new address at Plainfield Road, Metuchen, N. J.

Boston Engr. Firm Help Bogota Sewerage Plans

Camp, Dresser and McKee, Consulting Engineers of Boston, Mass., have been engaged in a joint venture with the Compania de Ingenieria Sanitaria, Consulting Engineers of Bogota, Columbia, by the Empresa de Aceuducto y Alcantarillado de Bogota, D. E.

Their work is to help prepare a master plan for sewerage and sewage disposal and storm drainage to serve the Special District of Bogota. The District has a present population of more than one million people, which represents an increase of about fifty per cent in less than ten years.

The master plan will serve a future population of about three million people.

Wilkins Receives Southwest Section Fuller Award

Henry Wilkins, Jr., of Houston was announced the recipient of the coveted George Warren Fuller Award for the Southwest Section of the AWWA. The announcement was made at the Section's 49th Annual Conference held in Galveston, October 16-19.

Henry Wilkins, Jr., is congratulated by Henry Graeser, (Center) Chairman, Southwest Section AWWA, and C. F. Wertz (Right) President, AWWA.

In the citation announcement, Wilkins was praised for his "many years of distinguished service . . . and for his untiring and enthusiastic promotion of the water works profession." He has been chairman of the Section and President of the Sam Houston Water and Sewage Association and of the Southwest Texas Regional Water and Sewage Short School. At present, he is Project Engineer for Turner and Coolie, Houston Consulting Engineers.

New Jersey Begins Reservoir Construction

The initial construction of the Spruce Run-Round Valley reservoirs was recently begun with groundbreaking ceremonies at the Round Valley site. Thus, construction has started less than two years after an overwhelming majority of New Jersey citizens voted in favor of the program.

In the intervening twenty-three months, the State acquired the necessary land and assisted former owners to relocate in adjoining areas. Surveys, core borings and soils investigations were completed and engineers completed detailed plans for the dams and dikes required and for the relocation of roads and power facilities.

Engineers went beyond the needs of the next quarter-century in their planning by providing that the present construction will fit into the future development plans for the State's long-range water supply program.

Morgan and Baumann Receive USPHS Grant

The National Institute of Health of the United States Public Health Service has announced a grant award of $56,571 to co-investigators Paul E. Morgan, P.E., Associate Professor of Civil Engineering and Dr. E. Robert Baumann, P.E., Professor of Civil Engineering of Iowa State University.

The grant will finance a 3-year study of "Design Requirements for Municipal Diatomite Filters".

Professor Baumann has returned to Iowa State after completing a year of post-doctoral study under a National Science Foundatiaon Science Faculty Fellowship at the University of Durham, Kings College, Newcastle on Tyne, England.

Komline Named to BDSA

Thomas R. Komline, president of the Komline-Sanderson Engineering Corp. of Peapack, N. J., today was recently appointed Assistant Director for Mobilization Planning, Water and Sewage Industry and Utilities Division, Business and Defense Services Administration, U.S. Department of Commerce.

Mr. Komline comes to BDSA on loan from his company under an arrangement by which industry makes key executives available for temporary assignment, usually six months, without compensation from the Government. The service also equips him for membership in the National Defense Executive Reserve, which would staff the operation of a production agency in event of emergency.

He is widely known as the inventor and designer of several types of filtration equipment used for water and waste treatment by municipalities and industries.

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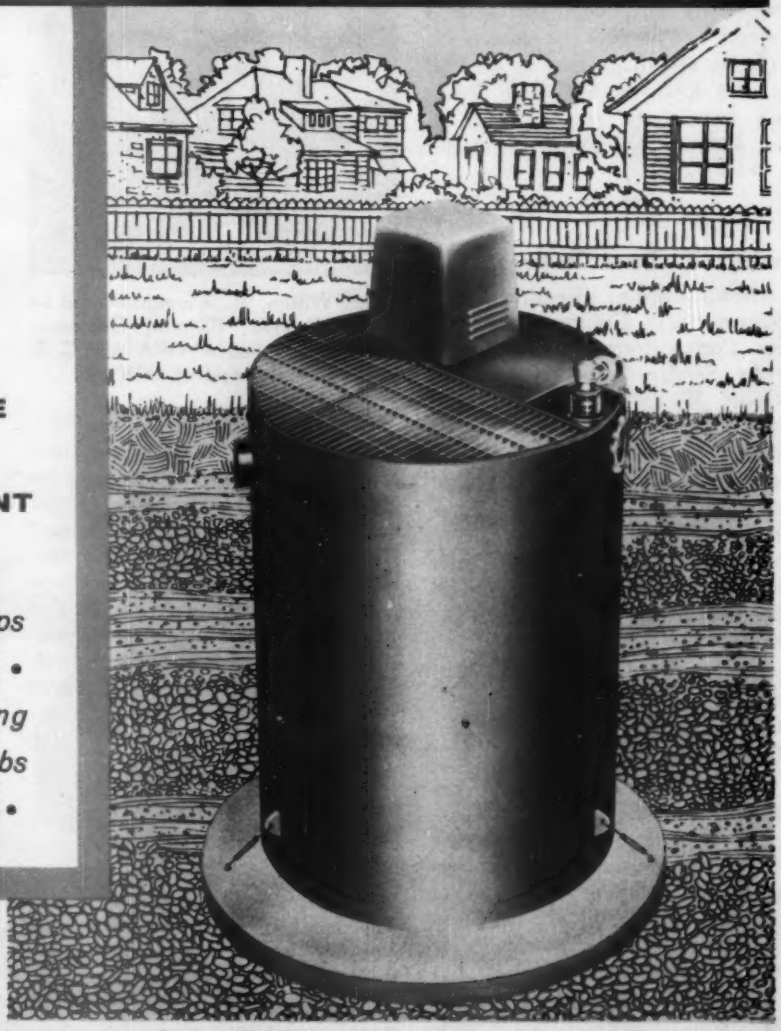

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Equipment News

Pellets Prevent Ice-Clogged Sewers

1201

Consolidated Paint & Varnish Corp., Cleveland, Ohio, is marketing its Ice-Chaser, a non-corrosive compound of heat-generating chemicals in convenient pellet form that is used to thaw ice-clogged sewers, thus preventing water back-up.

The product comes ready for use as packages and it spreads itself after being sprinkled on a surface, expanding its thawing area. The compound is marketed as being much faster in thawing action than ordinary rock salt.

Electronic Liquid Level Control

1202

Komline-Sanderson Engr. Corp., Peapack, N. J., announces the introduction of a newly developed electronic liquid level control for use with sewage ejectors.

Features of this unit are: Completely transistorized circuitry that does not overheat and does not exceed 10 watts power consumption; Resistance type control to establish

desired discharge cycle from 10 to 70 cycles; High water alarm system incorporated in the unit design; Utilizes only a single, short probe—no cleaning necessary; and a Moisture-proof compact case with a removable cover.

This unit is a part of all of the company's electrode type sewage ejectors now being manufactured, but it is available for installation on older ejectors of the electrode type.

Biological Filtration Plant for Sewage Treatment

1203

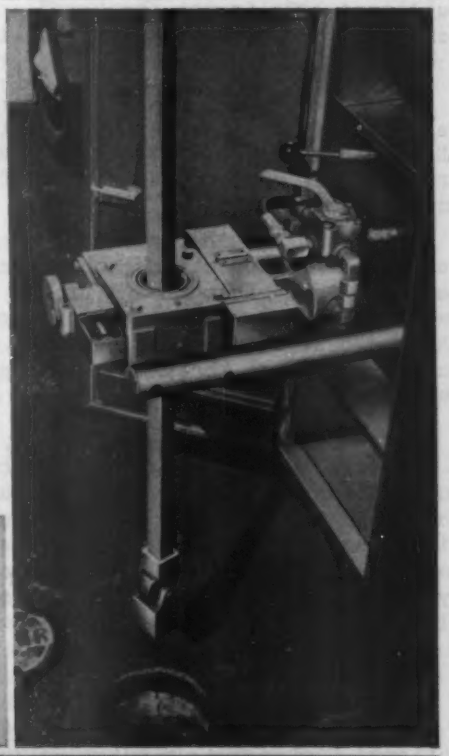
Link-Belt Co., Chicago, Ill., has developed a new, fully automatic, compact, factory-assembled, two-stage bio-filtration sewage treatment plant that has a 2:1 recirculation (1:1 in each stage) designed in accordance with criteria established by the "Ten States Standards for Sewage Works".

Called the Bio-Pac, this system was developed to help solve critical sewage disposal problems and eliminate the menace to health often created by inadequate sewage facilities caused by population shifts, the passage of more stringent anti-pollution laws and the increasing number of restrictions against the use of cesspools and septic tanks.

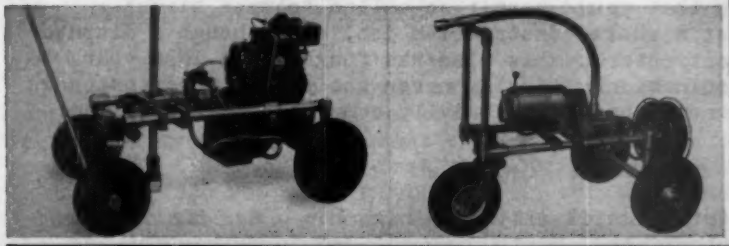
The new system is available in eight sizes and may be installed singly for populations from 50 to 500 persons or in multiples for larger populations. Units for populations

CONTINUED ON PAGE 14A

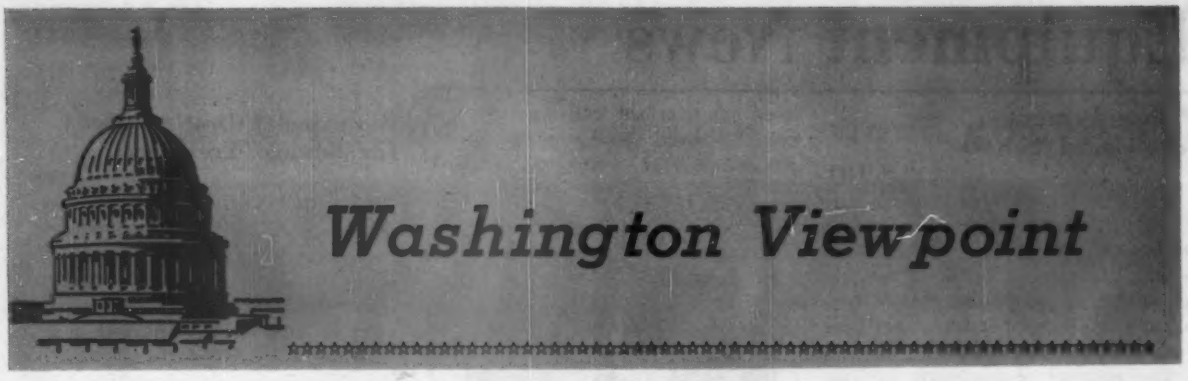
HYDRAULIC TRUCK MOUNTED VALVE OPERATORS PROVIDE ONE MAN CONTROL OF VALVES FROM 10" TO 60" SHIPPED FULLY ASSEMBLED, FOR MOUNTING IN ANY MAKE OF TRUCK BY YOUR OWN MECHANICS, WITHIN A FEW HOURS. HAS SAFETY DEVICE FOR DAMAGE PROTECTION ALSO POSITION INDICATOR.



PORTABLE 3-10 HP. ELECTRIC DRIVE



Makes EVERY VALVE Power Operated. Payne Dean & Co. Clinton, Conn.



Water and sewage works men can look for two things, certainly, as result of the National elections: An immediate call for more "new starts" in public works water projects; another—and probably successful—a try to increase Federal grants for construction of municipal sewage treatment works.

The "new starts"—mostly on Bureau of Reclamation and Corps of Engineers projects—is a foregone conclusion. The Eisenhower Administration itself has been loosening up its attitude in this regard over the past two years; the Democratic platform calls for it. And there's a plus in it for politicians: Not much actual money is involved in getting a new project started (even though it may commit the Government to heavy expenditures over a period of years).

On stream-pollution clean-up grants, there's little question that the presently authorized amounts ($45 million yearly) will be upped. You'll recall that Rep. John A. Blatnik of Minnesota pushed a bill all the way through Congress last year to double the annual grants, only to have it founder on a veto by President Eisenhower. With a Democratic President and with considerable support from many influential Republicans like former Speaker Joe Martin of Massachusetts, there's little doubt that some sort of a rise in grants will go through this time.

* * *

Overall, however, don't look for very many spectacular changes in Government direction or spending—for the first year at least—under the changed Administration. The basic reasons are two: The razor-thin margin in popular vote between the two Presidential candidates; and the fact that the make-up of Congress is practically undisturbed.

That doesn't mean that a lot of previously-defeated legislation—such as added aid for school construction; urban renewal and depressed-area aid; and probably a raise in the "minimum wage floor" (to around $1.25 an hour)—won't go through. Fact is that there's little disagreement on principles between the two parties in these areas. Most of the previous trouble has centered on wording and definitions. But what does go through won't represent any major departure from established patterns.

* * *

One area in labor legislation, however, will bear a careful eye by engineers and contractors. It is certain that the Building Trades unions will make another concerted drive to get legislation that would permit so-called "common situs" picketing, to permit them to picket a whole construction job, even though a dispute may concern only one of many subcontractors. This plan was fought hard last year by contractor and engineering organizations, finally never got to the Congressional floor for a vote. But with Mr. Kennedy apparently heavily committed to labor, you must expect another try.

* * *

Health, Education & Welfare Department officials have high hopes for their National Conference on Water Pollution, this month (Dec. 12-14) in Washington. As you know, the meeting was called by HEW to obtain "vigorous discussion" that might lead to substantial agreement on: (1) National goals for water pollution control; (2) specific programs needed to meet such goals.

Plenary sessions will be held on the first and third days of the meeting, a panel discussion (four separate panels) on the second day. More than 1,000 engineers, officials, labor leaders—even representatives of sportsmen's groups—had agreed to come by late November. More than 70 speakers had been lined up.

* * *

Driving to strengthen the top command of the Public Health Service (in line with recommendations of a recent study), PHS has created three new positions, and named men to fill them. Men and divisions are: Dr. James M. Hundley, to be an Assistant Surgeon General and fourth in command in PHS, with special responsibility in field relationships with regional offices; Harry Hanson, named Associate Chief of the Bureau of State Services, with the rank of Assistant Surgeon General, to function in the area of environmental health activities; Dr. A. W. Christensen, Associate Chief, Bureau of State Services, concerned with community health services. (Mr. Hanson will temporarily continue as Director of PHS' Sanitary Engineering Center in Cincinnati.)

* * *

The continuing battle in Washington and its burgeoning suburbs over the location of a new trunk sewer from the now-building Dulles International Airport at Chantilly, Va., to the City, has pointed up a serious consideration for sanitary engineers and city planners.

The consideration: The sewer line, in today's conditions, controls the growth of suburban areas just as much as did the old trolley lines of some generations back. In a densely populated area, septic tanks and cess pools aren't enough. So, the moment a new sewer line is planned, housing developments follow it—just as surely as they followed the trolleys and subway lines.

A case in point is the present plan to bring the big trunk sewer from Chantilly (28 miles west of Washington) to the Potomac Valley, down the Valley and through a tunnel to the Maryland shore, thence to city treatment plants. Planners are afraid that this scheme would bring immediate pressure for housing development along the river's forested banks, upsetting almost every long-range program for area development now on the books. Engineers argue, without refutation, that Valley location is the best available for a line. But the National Capital Planning Commission and local planning groups are afraid that local communities won't be able to withstand the pressures that will arise for development.

* * *

Air Force's search for a better waste disposal system, for use in arctic areas, could result in a new adaptation of the type of small metal or plastic toilets used on boats. If used in a fuel-oil emulsification system, in conjunction with an oil-fired incinerator, it may be the answer to present problems according to an Air Force research survey. The boat-type toilet system simply includes a hand pump, or may employ gravity feed, requires no electric pumps or safety features. Mechanical disintegration showed more promise than chemical additives disintegration in a disposal process where fuel oil is used, according to the Air Force. (You can get a copy of the full report—for 50 cents—from the Office of Technical Services, Department of Commerce, Washington 25, D.C. Ask for "A New Method of Waste Disposal for Isolated Areas in the Arctic".)

* * *

Concerted action to improve control of weed growths has reduced water and incidental losses by nearly $16 million a year on Bureau of Reclamation and other irrigation systems and 32 canal company systems estimated total water losses due to weeds at 1,966,000 acre-feet in 1957 in the 17 Western states. This is enough to irrigate 330,000 to 780,000 acres of cropland, according to BuRec engineers. A report on the survey, and what has been done in weed control, has been issued by the Agricultural Research Service of the Department of Agriculture, as ARS Publication 34-14.

* * *

Equipment News

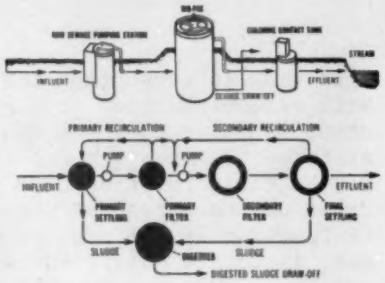
CONTINUED FROM PAGE 11A

of 50 to 200 persons are shipped factory-assembled; units for populations of 250 to 500 persons are shipped in large sub-assemblies for fast field erection.

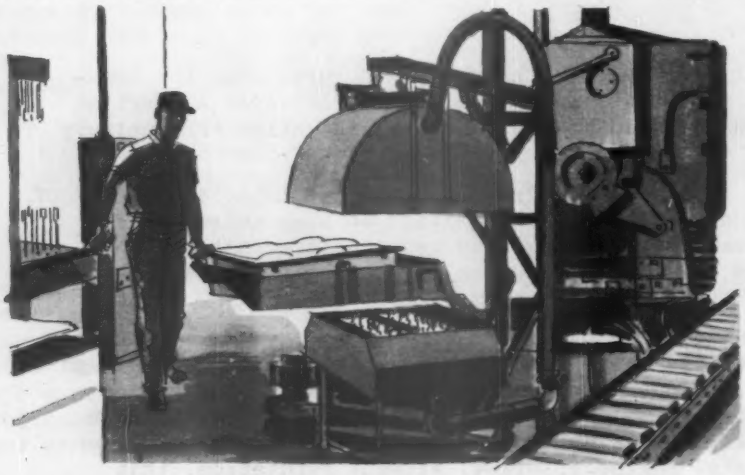
Treatment with this process consists of removing part of the suspended solids and part of the five-day BOD in a primary settling compartment. The sewage is then pumped to two bio-filters operating in series where aerobic bacteria remove 85 to 95 per cent of the raw sewage solids and BOD to produce a stable effluent, after passing through a secondary settling compartment.

In operation, raw sewage first flows by gravity or is pumped to the primary settling compartment for the first stage of separation. The resulting effluent is then pumped to the primary filter for initial bacterial action.

The primary effluent is divided into two portions: One portion is recirculated to the primary settling compartment; the other is pumped to the secondary filter. Sludge from both the primary and final settling compartment goes into the digester



where it is completely digested to a stable product. Where chlorination is required, a separate chlorine contact tank is available.



The M & H Spirit

There are those who might believe that a valve is just a valve. They might say: "What's in a name? All valves are made of about the same iron and bronze – so what?"

The answer is that one valve can be better than another because it is more skillfully designed and the men who make it are craftsmen who take greater pride in their work. The honor and honesty of a man – his veracity, fidelity and sincerity – is best shown by his acts.

It is by their daily work at M & H that the attitude of M & H personnel toward M & H products takes on form and substance. We call it the M & H Spirit – and it is an inherent factor in the quality and operating efficiency of an M & H Valve or Hydrant.

Thirty-four years of M & H history proves that an M & H Valve or Hydrant is in a class by itself. Its record of efficient trouble-free service has caused the Company to grow from 60 to 500 employees, with a present annual payroll of over $2,000,000.00. It has so rapidly increased in use throughout the U. S. and foreign lands that M & H Company has become one of the leading industries in its field.

(No. 7 of a Series)

M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF WALWORTH

Oxidation Plants Have Comminuting Pump Screen

1204

American Well Works, Aurora, Ill., is offering its Oxy-Pak packaged, fully automatic total oxidation plant that features a new arrangement of a recently developed comminuting pump screen with its Aircomb non-clog diffusers.

This screen is suited for both small and medium size plants and is designed to be practically carefree. In case of a power failure, the flow will continue through the bar screen which is an integral part of the system.

In operation, flow entering the aeration tank is immediately mixed with the raw sludge and return sludge. The self-adjusting orifices of the Aircomb eliminate the danger of clogging.

Pipeline Maintenance— By TV

1205

National Rodding Corp., Chicago, Ill., has made available a pipeline

repair service that utilizes a small, transistorized television camera, equipped with its own light source

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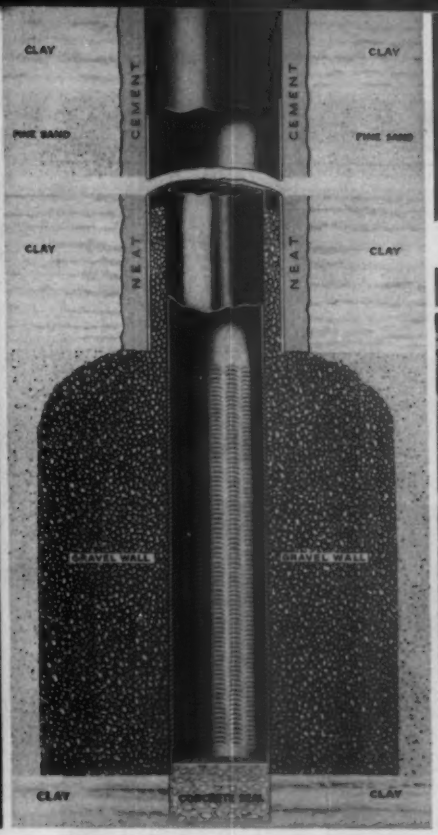


WATER WATER WATER

With A Layne Drilled Well Layne knows where the water-bearing formations are located. They have been drilling wells for over 75 years. This experience comes from searching and researching water aquifers. Knowing *where* to drill is half of the success—knowing *how* is the other half. In drilling a straight well experience counts—and you can count on Layne. Layne specializes in water well drilling. To get a good start for a water supply—you need a good well. You get a good, producing well when you specify a Layne drilled well. *Bulletin No. 100*

With A Layne Gravel Wall Well This technique and resulting arrangement of the new 134 Shutter Screen and gravel (shown here) permits the free flow of water into the well and affords the following advantages: larger shutter screen openings, reduced friction, reduced draw down and pumping head—thereby reducing pumping costs, increased specific capacity and more effective retention of native sands. Cemented wells are installed if indicated, and result in greater purity of supply as well as increased life of the well. *Bulletin No. 900*

With A Layne Vertical Turbine Pump Whatever the pumping requirement, there's a Layne pump to meet any pumping conditions. Layne Vertical Turbine Pumps come in a wide range of sizes and capacities, delivering 30 to 20,000 GPM and requiring from 4 to 42 inch well casings. The complete line of Layne Pumps include: Deep Well Vertical Turbine (oil or water lubricated), Short Coupled Vertical Turbine, Propeller, Mixed Flow, Fire Pumps and Volatile Liquids Pumps, Regular and "In-Line" Submersible. *Bulletins No. 200 (oil) 201 (water)*

LAYNE OFFERS COMPLETE WATER SERVICE: Initial surveys • explorations • recommendations • site selection foundation and soil-sampling • well drilling • well casing and screen • pump design, manufacture and installation construction of water systems • maintenance and service • chemical treatment of water wells • water treatment—all backed by Layne Research. Layne services do not replace, but coordinate with the services of consulting, plant and city engineers.

Layne SINCE 1902

WORLD'S LARGEST WATER DEVELOPERS

LAYNE & BOWLER, INC., MEMPHIS

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

Sales Representatives in Major Cities

Equipment News

CONTINUED FROM PAGE 14A

and enclosed in a waterproof casing, that will fit inside a 4 in. pipe.

The camera is connected to a control cable (it may be as long as 500 ft) which leads to a mobile television control and viewing room. Inside the room, a technician controls the speed at which the camera is fed into the pipe. As the camera moves along the pipe, the technician watches the screen to spot breaks and obstacles. A movie camera records the picture shown on the screen making a permanent record for future use. The camera can be stopped at any point and a photograph made of the image on the screen.

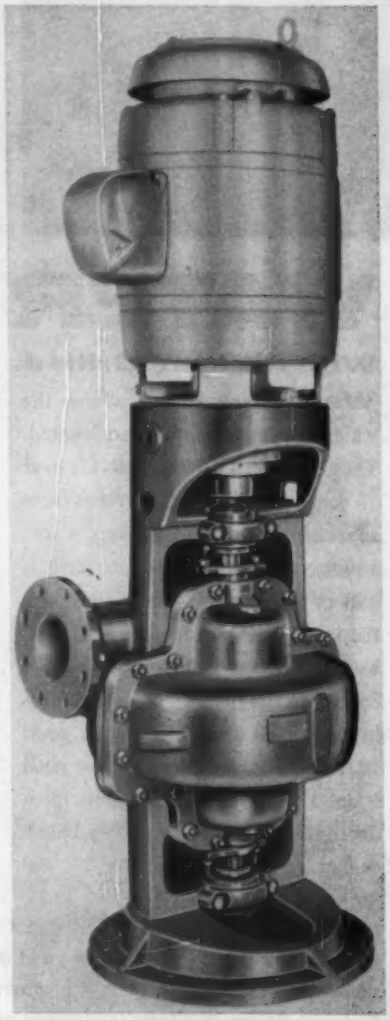
When a break is spotted, the operator notes the length of the cable that has been fed into the pipe and pin-points the exact location of the leak. The repair itself can be made by any standard method.

The principle and most important advantage of this system is savings made in repair costs. Because repair crews know exactly where to dig or otherwise locate the leaky line, time, material, labor and frequently expensive construction costs are eliminated.

Vertical Two-Stage Pumps

1206

Aurora Pump Div., New York Air Brake Co., Aurora, Ill., announces the development of a new line of vertical, two-stage, split case, centrifugal pumps especially designed to reduce space requirements to a minimum.



Called the AJV Series, these pumps have a capacity range to 1400 gpm at heads to 425 feet. The pump case is split parallel with the impeller shaft, and the bearing housing

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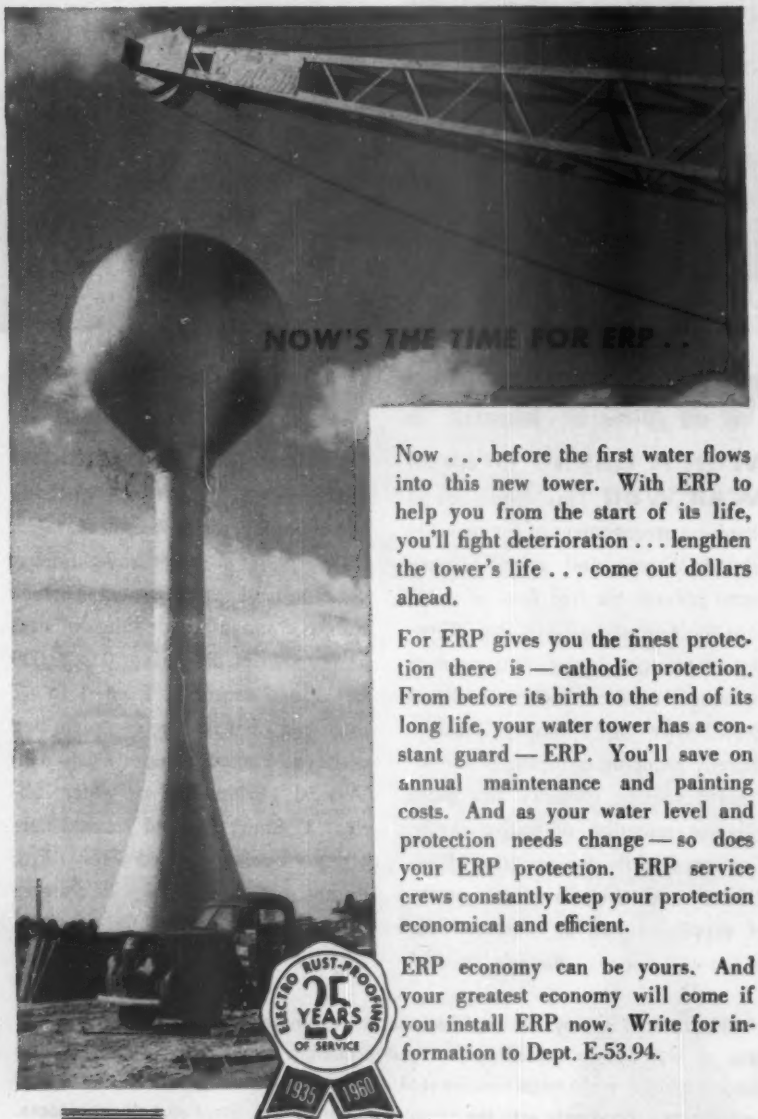


Now . . . before the first water flows into this new tower. With ERP to help you from the start of its life, you'll fight deterioration . . . lengthen the tower's life . . . come out dollars ahead.

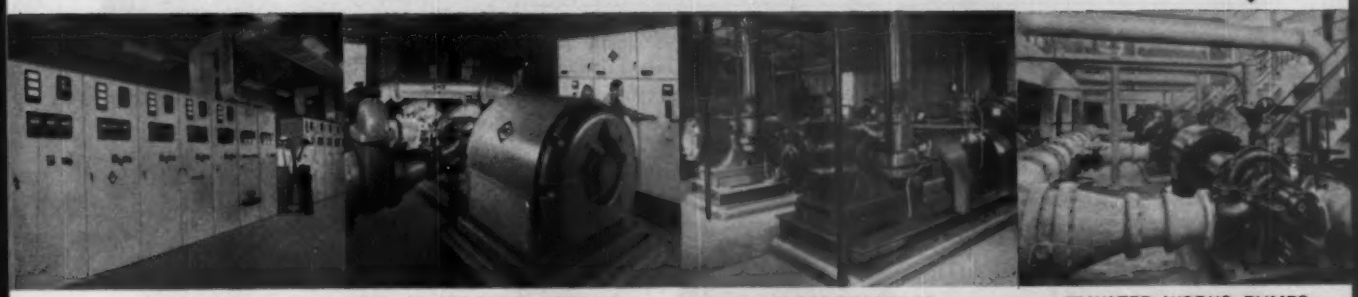
For ERP gives you the finest protection there is — cathodic protection. From before its birth to the end of its long life, your water tower has a constant guard — ERP. You'll save on annual maintenance and painting costs. And as your water level and protection needs change — so does your ERP protection. ERP service crews constantly keep your protection economical and efficient.

ERP economy can be yours. And your greatest economy will come if you install ERP now. Write for information to Dept. E-53.94.

ERP CATHODIC PROTECTION SINCE 1935

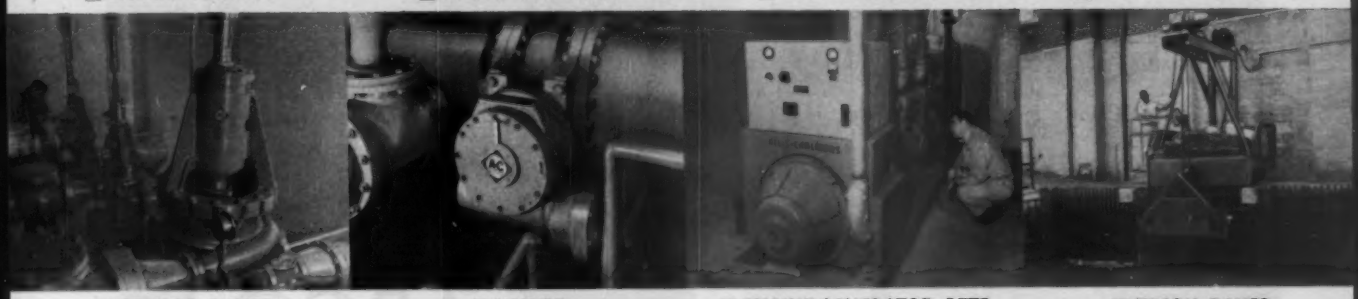
ELECTRO RUST-PROOFING CORP.
A SUBSIDIARY OF WALLACE & TIERNAN INC.
30 MAIN STREET, BELLEVILLE 9, NEW JERSEY
CABLE: ELECTRO, NEWARK, N. J.

ALLIS-CHALMERS



☐ SWITCHGEAR ☐ ELECTRIC MOTORS ☐ COMPRESSORS ☐ WATER WORKS PUMPS

☐ MOTOR CONTROL ☐ STEAM TURBINES ☐ ROTARY DRYERS ☐ VIBRATING SCREENS



☐ SEWAGE PUMPS ☐ VALVES ☐ ENGINE-GENERATOR SETS ☐ TRASH RAKES

☐ TRACTORS ☐ COMPACTOR MILL ☐ DEAERATORS ☐ BLOWERS

Test your public service product "I.Q."

What's our line?

In addition to all the products shown above, there's another dozen* supplied by Allis-Chalmers. Whether you need equipment for sewage plants, water works, municipal power plants, or street and highway maintenance . . . Allis-Chalmers is your most convenient single source.

Municipalities all over the world have modernized, expanded and prospered with expert engineering and application help from Allis-Chalmers. ***For complete details, call your nearby A-C office, or write* Allis-Chalmers,** ***Milwaukee 1, Wis.***

***Additional Public Service Products — Transformers, condensers, circuit breakers, voltage regulators, substations, generators, vacuum pumps, sifters, engines, lift trucks, graders, and other earth moving equipment.** A-1311

Equipment News

CONTINUED FROM PAGE 16A

supports, suction and discharge flanges are integral with the vertical base section of the case, thus allowing for removal of the rotating element without disturbing either suction or discharge connections.

These pumps are considered particularly suitable for use on municipal and industrial water services, pressure booster service, cooling towers, circulation and boiler feed.

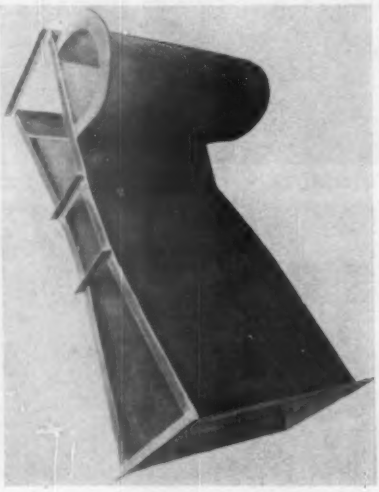
Parshall Flumes

1207

Plasti-Fab, Portland, Ore., announces the availability of a new Parshall flume built of corrosion-resistant fiberglass, reinforced polyester. Some of these new units are now in operation in municipal sewage and industrial waste installations.

The units have throat sizes of 3, 6, 9 and 12 in. and are available with or without integral float wells and molded in level gauge. The ends are flanged for bolting. Lightweight, the 3 in. size weights about 15 lbs, the 12 in. about 45 lbs.

On some municipal installations, small flumes have been installed to measure sewage from specified dis-



tricts, pending future growth of the area. When a larger flume is required, the small unit may be removed and a larger one installed. In other cases, small flumes have been installed inside existing oversize flumes awaiting the time when flows will increase.

pH Meter

1208

Coleman Instruments, Inc., Maywood, Ill., has made available a pH meter called the Companion that provides simplicity of operation with a routine precision within 0.05 pH.

The instrument has a 6¼ in. wide scale which covers the 0-14 pH range; it permits direct reading to 0.02 pH. The scale is mirror-backed to eliminate reading errors caused by parallax. Three controls regulate all instrument operations, but only one is required for routine measurements.

The unit is line operated and has full stabilization against the effects of varying supply voltage.

Machine for Cutting Holes in Pipeline

1209

Steffan Mfg. Corp., Salem, Ohio, is offering a simplified machine for cutting 90° holes in pipe, tanks and flat plate. Three unit sizes permit

CONTINUED ON PAGE 21A

AUTOMATICALLY CONTROL YOUR PUMPS

Preset

- LENGTH OF TIME
- TIME OF DAY OR NIGHT
- DAYS OF THE WEEK
- ON OR OFF HOURS
- SKIP DAYS

Synchro-Start AUTOMATICALLY will start and stop your pumping engine during any periods you require.

This control uses no commercial current as it operates from the engine's battery. The cabinet is double weather-proof and has knockouts for conduit wiring.

Write for Detailed Information

Please include all pertinent data regarding the installation and the engine you wish equipped.

SYNCHRO-START PRODUCTS, INC.
Since 1932
[illegible] NORTH RIDGEWAY AVENUE • SKOKIE, ILLINOIS

APCO
CAST IRON
PIPE

Super De Lavaud Cast Iron Pipe 3" to 24" in modern long lengths. Bell and Spigot, Altite Joint® and Mechanical Joint.

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DIVISION OF WOODWARD IRON COMPANY
General Offices—General Sales Office
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[illegible] Dwight Building, Kansas City, Mo. 18505 W. Eight Mile Rd., Detroit 41, Mich.
[illegible] Southern Ave., South Gate, Calif. 2101 N. Webster St., Kokomo, Ind.

ALTITE JOINT® Protected by Patent

DIG TRENCH AND BELLHOLES IN SINGLE PASS

The Cleveland JS-30 Trencher digs bellholes at pipe joints, digs flush to obstructions, slopes as it digs.

Note the ample-width bellhole in the foreground above. The JS-30's exclusive power-shifted digging wheel shifts 2½ feet to each side of center to dig bellholes like this and to keep trench in line even when crawlers are being steered around side obstructions.

The JS-30's wheel power-*tilts*, too—saves blocking and cribbing when either crawler track is higher than the other on curbs, side slopes, etc.

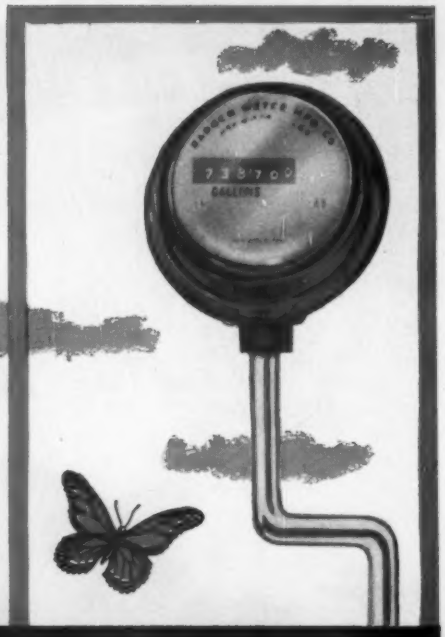
Note, too, how the JS-30's power-shifted V conveyor with operator-controlled speeds up to 1,000′ per minute—another Cleveland exclusive—easily handled the big spoil volume from the wide-sloped trench. The JS-30 sloped the trench to 6′ top width as it dug.

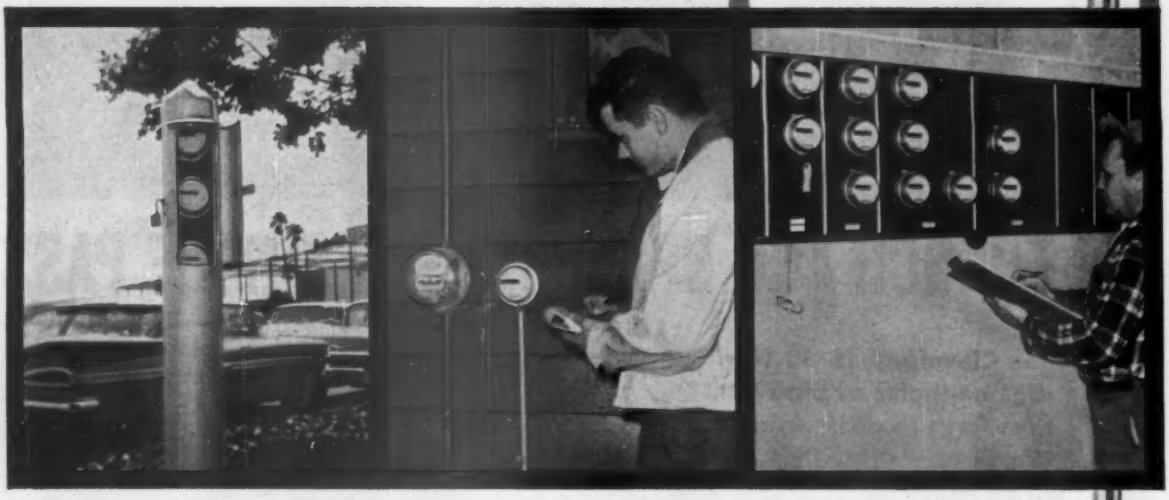
The JS-30 is a trencher of amazing utility —get all the facts now, from your Cleveland distributor.

CLEVELAND TRENCHER

THE CLEVELAND TRENCHER CO., 20100 ST. CLAIR AVE., CLEVELAND 17, OHIO

Badger *Read-o-Matic's** cost-cutting story is big as all outdoors





*Pat. applied for in U.S.A. and foreign countries.

All over the country water departments are cutting meter-reading costs and increasing efficiency with Badger Read-o-Matic outdoor meter-registers.

Accessibility is the big advantage of this self-contained register. Read-o-Matics are installed *outside*, often in convenient "reading stations" which a meterman can read quickly and easily. This system is safer, too, because it completely eliminates the dangers involved in climbing down into underground vaults and other inconvenient locations.

Install this faster, lower-cost reading system in your water department. Write for literature or call your Badger representative for a demonstration.

Badger Meter Mfg. Co.

4545 W. Brown Deer Rd.
Milwaukee 23, Wisconsin

12-60

Equipment News

CONTINUED FROM PAGE 18A

cutting perpendicular holes to 18 in. in diameter without using cams, patterns or layouts. Lighweight, the machine may be used with electric drive or may be hand operated in the field.

Cutting is accomplished with an oxygen, acetylene torch arrangement which leaves clean edges, burr-free and having good weldability. The machine provides holes automatically in both round and elliptical form for 90° to 45° fittings.

Magnetic Drum Programming for Utilities

1210

Bailey Meter Co., Cleveland, Ohio, announces a new solid-state digital information systems for measuring, scanning, and logging variables in power plant operation. Called the #750, this completely modularized system is believed to be the first non-computer industrial application of magnetic drum programming for this type of service.

At one installation, the system scans 110 variables including currents, voltages, power and gate positions. Variables are scanned at the rate of one per second and all points are logged out once an hour or upon demand. High and low set points may be programmed for any of all variables so that an off-normal condition will actuate both a visual and audible signal.

Magnetic Drive Meter

1211

Badger Meter Mfg. Co., Milwaukee, Wis., has introduced a ⅝ in. magnetic drive meter which operates

on the nutating disc principle; the unit is constructed with a disc meter chamber. It is driven by a magnetic coupling designed to drive any register or meter-driven accessory on the market.

The register face has digits that are ¼ in. tall, permanent and molded integral with the wheel. A sixth number wheel has been added, extending the totalizer capacity of the meter to 10 million gallons (1 million feet).

Other features include a "tamperproof", hermetically sealed register which can be removed underwater without disturbing the meter in the line and availability either as a complete meter or in a modernization kit.

Safety Control System

1212

California Controls Co., Oakland, Calif., is offering the new non-electric Calcon Safety Control System

CONTINUED ON PAGE 23A

EXETER, N. H., *has a new* STANDPIPE

When New Englanders build, they have long-established habits of building soundly and lastingly. And Exeter, N. H., is no exception. The elm-shaded streets of the town display a succession of handsome colonial homes, sturdily constructed a century and a half ago.

These same habits are strong in the minds of the townspeople today. Thus it was natural for them, when growth dictated a new 1,000,000 gallon standpipe, to specify *steel.*

. . . built of STEEL to AWWA standards!

STRENGTH
TIGHTNESS
ELASTICITY
ECONOMY
LONG LIFE

. . . these are inherent qualities of welded *steel* construction. Compare *steel* tanks with other types . . . you'll see why "steel tanks store water best." You can always specify *steel* tanks with confidence.

More Than 10 out of 11 Water Storage Tanks Are Constructed of STEEL

STEEL PLATE FABRICATORS ASSOCIATION
105 West Madison Street • Chicago 2, Illinois

STEEL PLATE FABRICATORS ASSOCIATION

Pennsalt Water Works Grade Chlorine

...made pure

Pennsalt chlorine gets "scrubbing tower" treatment for *extra* purity.

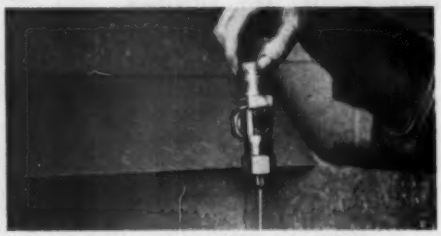
Pennsalt Water Works Grade Chlorine gets the added purification of special chlorine processing techniques pioneered by Pennsalt many years ago. This special processing removes trouble-making organics and traces of moisture. The result is a high quality chlorine that's ideal for dependable chlorination.

Pennsalt Water Works Grade Chlorine is available in 100- and 150-lb. cylinders, and in one-ton containers in multiple-unit rail cars. Pennsalt Ferric Chloride is available for fast sedimentation in sewage processing. Industrial Chemicals Division, PENNSALT CHEMICALS CORPORATION, Three Penn Center, Philadelphia 2, Pennsylvania.

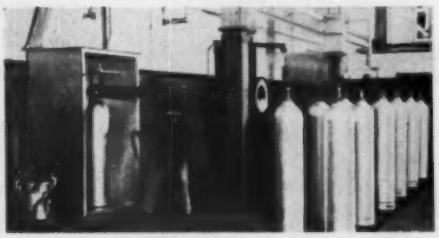
®
Pennsalt Chemicals
ESTABLISHED 1850

...stays pure

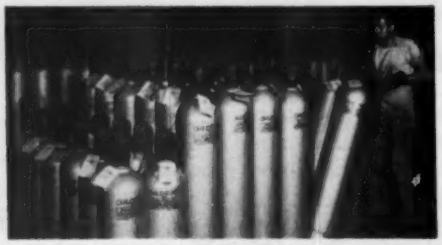
Before refilling, Pennsalt chlorine cylinders are carefully cleaned and inspected . . .



All valve parts completely reconditioned . . . valve is reassembled using all new packing . . .



Cylinders are cleaned and painted . . .



Inspected, tagged, and ready to go.

Pennsalt chlorine *stays* pure because of the special precautions taken in packaging it. Pennsalt's comprehensive program of cylinder reconditioning and inspection is your best insurance against contamination. The *delivered purity* of this quality product is backed up by a half century of experience.

Industrial Chemicals Division

SALES OFFICES: ATLANTA • CHICAGO • DETROIT • NEW YORK
PHILADELPHIA • PITTSBURGH • ST. LOUIS • APPLETON
TACOMA • PORTLAND

INDUSTRIAL QUÍMICA PENNSALT, MEXICO CITY

PENNSALT CHLORINE is made at Calvert City, Ky., Portland, Ore., Tacoma, Wash., Wyandotte, Mich., and Mexico City

For fast service on...

Pennsalt Water Works Grade Chlorine

contact your nearest Pennsalt sales office or any of these distributors

ACID PRODUCTS CO. Chicago, Illinois
BADGER CHEMICAL CO. Milwaukee, Wisconsin
CARRIER-STEPHENS Lansing, Michigan
P. H. DOREMUS & CO. Paterson, New Jersey
EATON-COLBY CHEMICAL CO. Columbus, Ohio
FIRE EQUIPMENT WELDING SUPPLY Zanesville, Ohio
HAVILAND PRODUCTS CO. Grand Rapids, Michigan
HERBERT CHEMICAL CO. Cincinnati, Ohio
HOLLY CHEMICAL CO. Mount Holly, New Jersey
INDUSTRIAL CHEMICAL SUPPLY CO. Springfield, Illinois
LYON CHEMICALS, INC. St. Paul, Minn.
MIDDLESEX CHEMICAL CO. Milltown, New Jersey
THE OPALCO LABORATORIES, INC. McKeesport, Pennsylvania
OVERTON CHEMICAL SALES CO. Sumner, Iowa
STEVENS CO. South Bend, Indiana
TAYLOR SALT AND CHEMICAL CO. Norfolk, Virginia
ULRICH CHEMICAL, INC. Indianapolis, Indiana
VALLEY CHEMICAL & SOLVENTS CORP. Pekin, Illinois
VALLEY OXYGEN CO. Bay City, Michigan

Pennsalt Chemicals
ESTABLISHED 1850

Equipment News

CONTINUED FROM PAGE 21A

that is sensitive to a wide range of temperatures, pressures or both in combination and can be assembled into compact units to meet the needs of many diversified operations.

The unit operates through a small captive charge of compressed air and provides immediate, positive action response. When dumped to atmosphere by pressure or temperature sensing devices, the system puts into operation almost any type of pilot operated valve, switch, warning or other control.

This self-powered safety control can sense pressures up to 2000 psi. It has its own source of pneumatic power and is not dependent on outside power which could fail and shut down equipment unnecessarily.

1750 RPM Pumps Designed For Large Wells

1213

Sumo Pumps, Inc., Stamford, Conn., has announced the introduction of a new line of high capacity, heavy duty 1750 rpm submersible pumps. The pumping capacities of these units range from 400 to 3300 gallons per minute; horsepower range is from 40 to 125; and they are suitable for installation in 12" (inch) wells or larger.

The pump bowls are constructed of enamel-lined cast iron; the impellers are of smooth bronze. The motor is the "Wetstator" type with plastic-covered winding designed for continuous underwater operation, and they are equipped with a special plastic and ceramic sand seal which protects the motor against abrasives and corrosive water.

Control Stations For Automatic-Manual Pneumatic Systems

1214

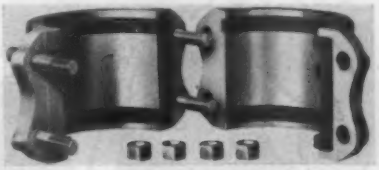
Republic Flow Meters Company, a subsidiary of Rockwell Manufacturing Co., Chicago, Ill., has introduced a line of pneumatic control stations for "bumpless" transfer between automatic and manual operation; as well as for set point loading and manual loading. Designed to operate with Republic's Vector Series instruments and controls, the new control stations are accurate within 1 per cent of full scale. The controlled variable is indicated on automatic and manual operation.

Control stations have input ranges of 3-to 15-psig with air consumption of less than 0.2-scfm. Red outer pointer indicates manual loading pressure and black center pointer indicates automatic loading pressure. Control stations are designed for standard panel mounting in 5¼ x 5¼ cutouts or space.

Ductile Iron Split Sleeve

1215

James B. Clow and Sons, Inc., Chicago, Ill., has introduced its new ductile iron split sleeve designed for



faster and the more convenient repair of 4, 6 and 8 in. transverse cast iron pipe underground breaks.

Features of this sleeve are its lightweight construction, short length and two-piece assembly which give it its handling characteristics. The sleeves are made of 70,000 psi tensile ductile iron for strength and durability.

Pump "Squeezes" Water Upward

1216

Peerless Pump, Hydrodynamics Division, Food Machinery and Chemical Corp., Los Angeles, Calif., is offering a pump that uses an exclusive, positive displacement pumping action to literally squeeze water upward.

Trade-named the "Hi-Lift", this pump employs a corkscrew-like rotor which rotates within a contoured stator. The action of the rotor creates a positive displacement action, moving a constant flow of water up to the surface.

The pump can be operated at one-half the normal pump speed (1760 rpm), thus assuring longer pump life and greater operating and maintenance economy. Furthermore, its unique long wearing rotor-stator

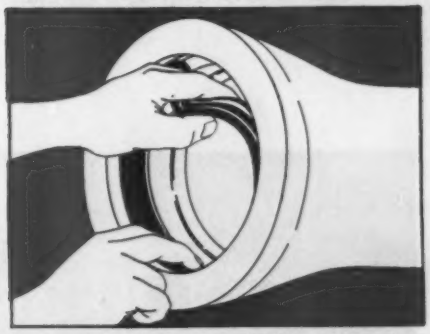
CONTINUED ON PAGE 29A

"It's an experiment . . . Ev'rybody claims layin' Tyton is as easy as fallin' off a log."

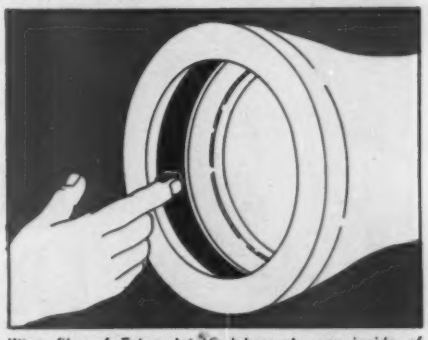
U.S. cast iron **PIPE** FOR WATER, SEWERAGE AND

TYTON®

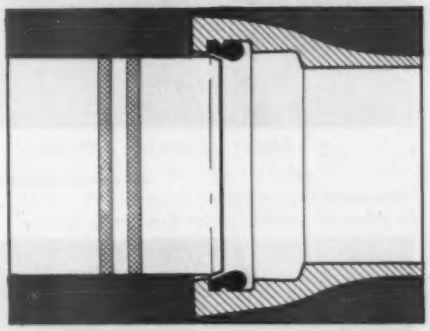
ONLY FOUR SIMPLE ACTIONS



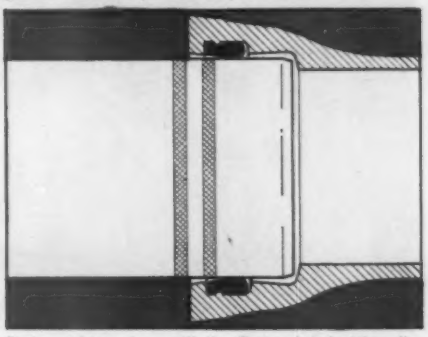
Insert gasket with groove over bead in gasket seat . . . a simple hand operation.



Wipe film of Tyton Joint® lubricant over inside of gasket. Your receiving pipe is ready.



Insert plain end of entering pipe until it touches gasket. Note two painted stripes on end.



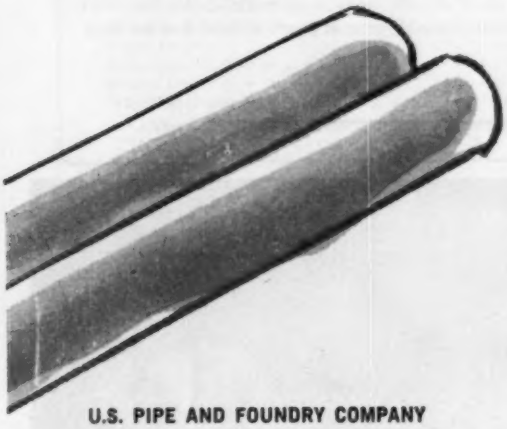
Push entering pipe until the first painted stripe disappears and the second stripe is approximately flush with bell face. The joint is sealed . . . bottle-tight, permanently! The job's done . . . . fast, efficiently, economically. Could anything be simpler?

almost as easy!

In their enthusiasm our hillbilly pals sometimes exaggerate.

Tyton Joint® pipe isn't quite as easy to install as falling off a log. But almost! One simple accessory and you're in business! No bell holes. No nuts, bolts, pots or ladles. Fewer weather delays, too. Tyton® can be installed in rain or wet trench, if need be. And even inexperienced crews can lay it.

Want more working days, less time, trouble in the trench? Tyton Joint pipe is your answer. Get the facts. Call or write today.

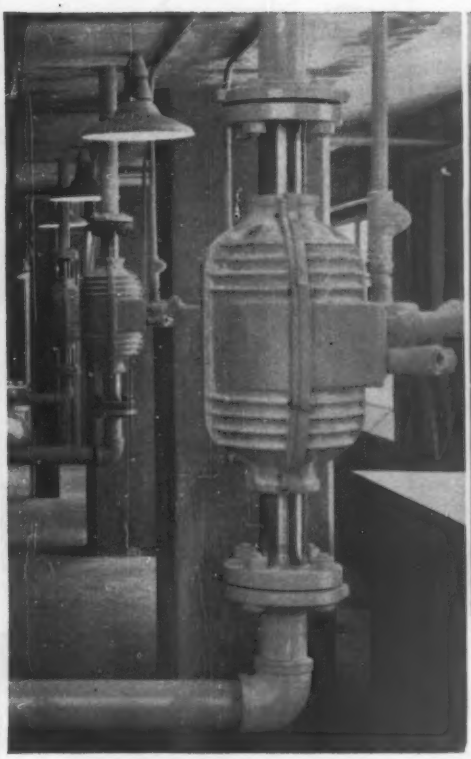


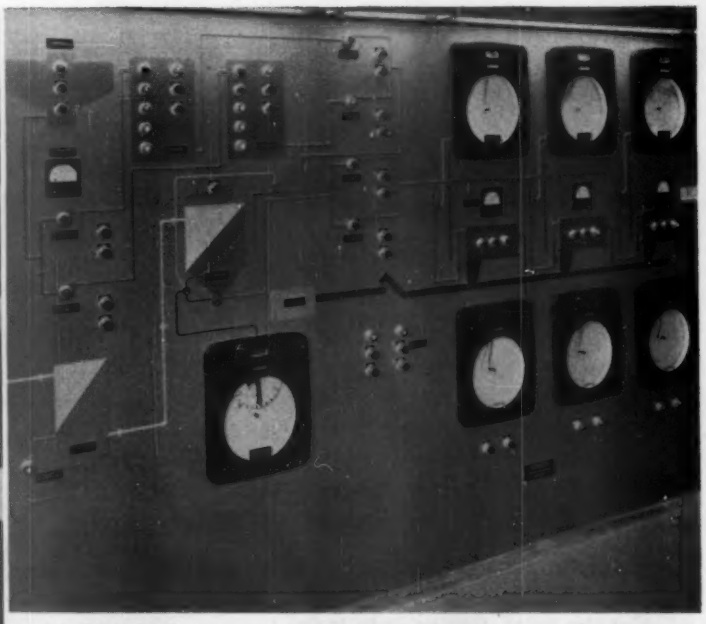
U.S. PIPE AND FOUNDRY COMPANY
General Office: Birmingham 2, Alabama

A Wholly Integrated Producer from Mines and Blast Furnaces to Finished Pipe.

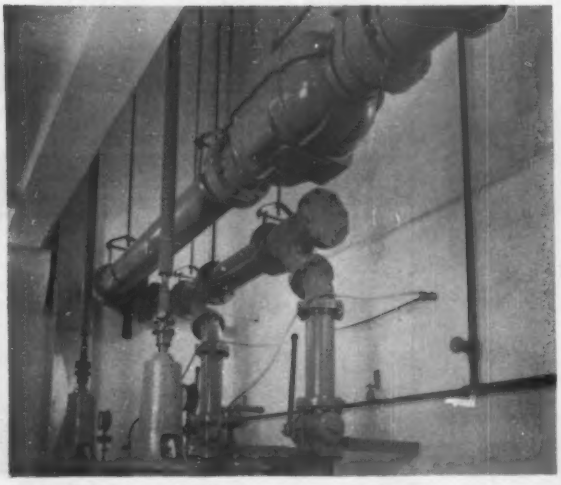
INDUSTRIAL SERVICE ® CAST IRON

Foxboro Magnetic Flow problems for

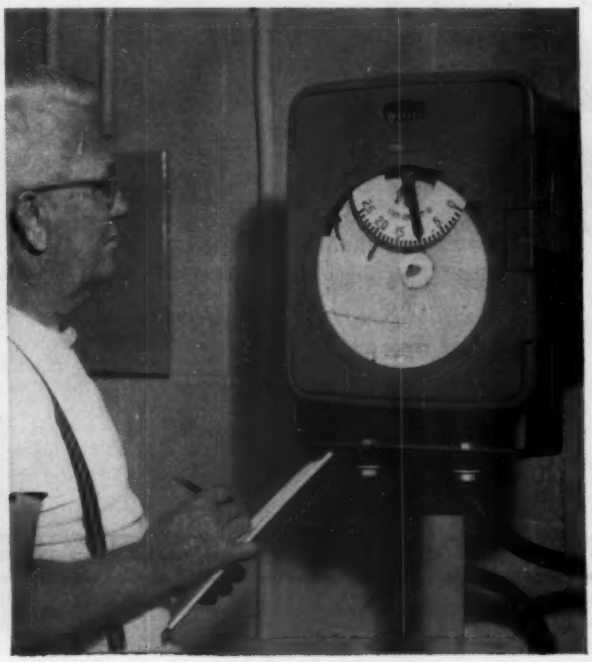




DAYTON, OHIO Three Foxboro Magnetic Flow Meters measure flow of sludge to centrifuges at Dayton's Lime Recalcining Plant. Designed around these meters, plant actually recovers up to 20% more lime than originally added to water. Graphic control panel in Feed End Building operates entire plant.



NEWPORT, R. I. At Newport, R. I. influent at the main sewage plant comes from both the town and a nearby Navy base. Determining how much of the total should be billed to the Navy is the job of the Foxboro Magnetic Meter and Foxboro Dynalog Recorder shown above.



Meters eliminate line restriction these municipal utilities

Introduced six years ago, the Foxboro Magnetic Flow Meter has proved its superiority for measuring water, sewage, sludge and other treatment plant flows.

Foxboro Magnetic Flow Meters have no flow restrictions of any type. No taps to get plugged or frozen, no seals or purges, no moving parts of any type. Measurement is made by electrodes flush-mounted in meter wall — then transmitted by electric cable to a Foxboro Dynalog* electronic recorder. Accuracy is ±1%.

Foxboro Magnetic Flow Meters have solved some of the toughest municipal measurement problems. Ask your Foxboro field engineer to show how it can help with yours. Or write for Bulletin 20-14. The Foxboro Company, 8912 Neponset Avenue, Foxboro, Massachusetts.

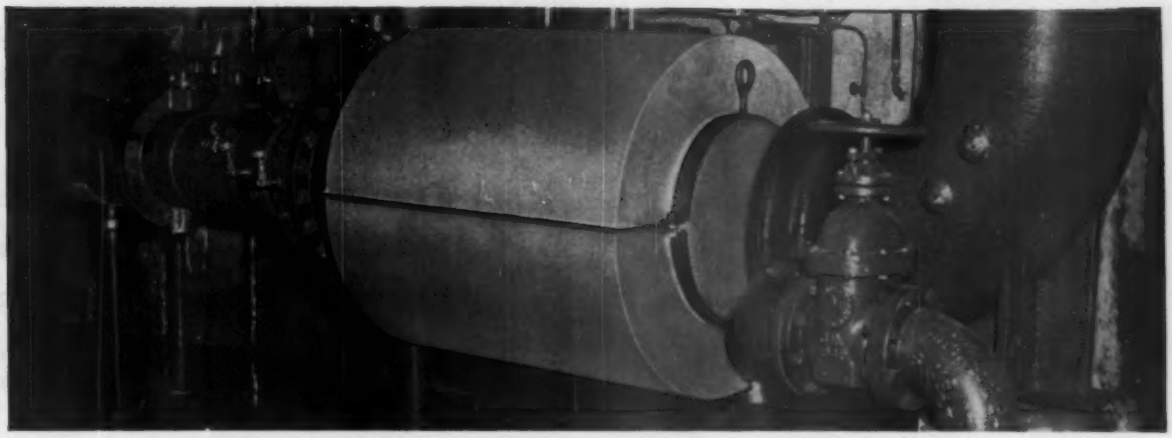
*Reg. U. S. Pat. Off.

Partial List of Progressive Communities Using Foxboro Magnetic Flow Meters

Benton Harbor, Michigan	— raw sewage
Hayward, Calif.	— water
Pittsburgh, Pa. (Allegheny County Sanitary Authority)	— raw sewage
Covington, Ohio	— return activated sludge
Medfield, Mass.	— water
Orange County, Calif.	— sewage
Warren Township, Michigan	— raw sewage and sludge
Bloomfield Township, Michigan	— water
Seattle, Washington (Lake City Sewage Plant)	— sludge
Milwaukee, Wisconsin	— sludge
Piqua, Ohio	— sludge
Arkansas City, Kansas	— sewage
Sidney, Ohio	— return activated sludge
Frazer, Michigan	— raw sewage

Meter sizes on these installations range from 3 inches to 6 feet.

FARMERS BRANCH, TEXAS Eight-inch Magnetic Flow Meter at a sewage lift station. Meter was installed below ground level, right next to elbow and valve, without affecting its measurement accuracy.



CHICAGO, ILLINOIS This 20" Foxboro Magnetic Flow Meter was installed in the South District Filtration Plant in April, 1956. Because it has no line restrictions, plant officials knew the meter would add no more pressure drop than an equivalent length of pipe. Note how it was installed directly downstream from an elbow.

FOXBORO

REG. U.S. PAT. OFF.

MUELLER® Tapping Sleeves and Valves
MUELLER CL-12 Drilling Machine

■ By using Mueller "quality-matched" equipment and machines, you eliminate the need for extra adapters and fittings, thereby reducing set-up time. The automatic power operation of the CL-12 Machine frees the operator for other work around the job-site, and reduces cutting time.

■ The total reduction of on-the-job time is one of the big reasons to standardize with Mueller equipment and machines. Ask the Mueller Representative in your area for complete details on this and many other safe, fast operations using quality Mueller products.

SPEED — another Basic Benefit from . . .

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles
In Canada: Mueller, Limited, Sarnia, Ontario

5577

Equipment News

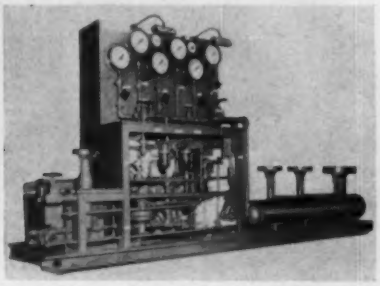
CONTINUED FROM PAGE 23A

pumping element commends this pump for sandy wells. Any sandy particles which may become momentarily depressed in the rubber when the rotor passes over it are quickly removed by the water flow as the rotor continues to turn.

Test Stand Reduces Down Time and Maintenance Cost

1217

Farris Engineering Corp., Palisades Park, N. J., now has available built-in-plant test stands manufactured to ASME requirements which will test all valves including Globe, Gate, Plug Cocks, Safety, and Relief plus other hydraulic-pneumatic equipment.



This new test stand is designed to eliminate expensive, time-consuming outside valve maintenance and related shipping costs. Valve inventory can be reduced to a minimum by using the test stand to reset valves so they may be used in the widest possible variety of applications and pressure variations.

Easy to operate, this universal stand requires no special skill or training. All controls are within reach on one panel with simple instructions printed on a metal plate. It is compact (10½′ x 3′), yet its wide range permits testing of pressure settings up to 2000 psi for air and 6000 psi for water.

Prefabricated Sewage Pumping Station

1218

Komline-Sanderson Engineering Corp., Peapack, N. J. is offering factory assembled, welded steel, prefabricated sewage pumping stations which incorporate either pneumatic sewage ejectors or standard sewage pumps. The stations are fabricated of ⅜″ thick steel for the wall sections and ⅝″ for top and bottom plates. The over-all stations include access ladders, balanced hinged doors, lights, dehumidifier, blower and sump pumps.

In the ejector station, heavy-duty cast iron pots are utilized with either electrode or pneumatically operated liquid level controls. Welded steel ejector electrode controlled pots are integrally fabricated with the steel shell of the station in either single or duplex types. Separate air receivers are utilized when required.

Ejector stations including two pots as large as 300 gallon capacity have been manufactured. Pumping stations incorporate vertical "non-clog" centrifugal pumps having gland seals and bubbler-type control systems for the adjacent wet well. The station walls are coated with epoxy resins.

Special electric control panels, spring-loaded check valves and inlet and discharge pipe connections extending outside, are standard items.

FOUR reasons why Ford covers offer greater protection and convenience for every meter box installation . . .

1 2 3 4

DOUBLE LID METER BOX COVERS

Designed to provide the utmost in frost protection for pit meters, the "Wabash Cover" has a total depth of 9½ inches. Its extra depth, sloping skirt and 4″ dead-air space between inner lid and top lid minimize heat loss from the top of the meter setting.

These covers can be provided in "standard weight" for ordinary service, or "extra heavy," when the lid will be exposed to traffic.

SINGLE LID METER BOX COVERS

Designed for sidewalk or lawn installation, Ford "Type A" covers are made for 15″, 18″, 20″ and 21″ meter boxes. Lids are inset.

Lifter Worm lock used on these covers helps speed meter readings. Screw jack action plus automatic attachment of the key to the bolthead make lid removal a simple, clean task.

MONITOR COVER

Designed for use on large tile — where a large lid opening is desirable — "Monitor Covers" consist of 1) a flange casting to fit on the tile, 2) a ring centered in place on the flange by a circular bead, and 3) a top lid with Lifter Worm Lock.

These covers can be used for 1½″ and 2″ meters . . . or for two or more smaller meters. Lid size permits meter reader to enter setting if necessary.

HINGED LID

Designed for same installations as other single lid covers, "Type X cover" features hinge effect so lid can simply be leaned back instead of lifted off while meter is read.

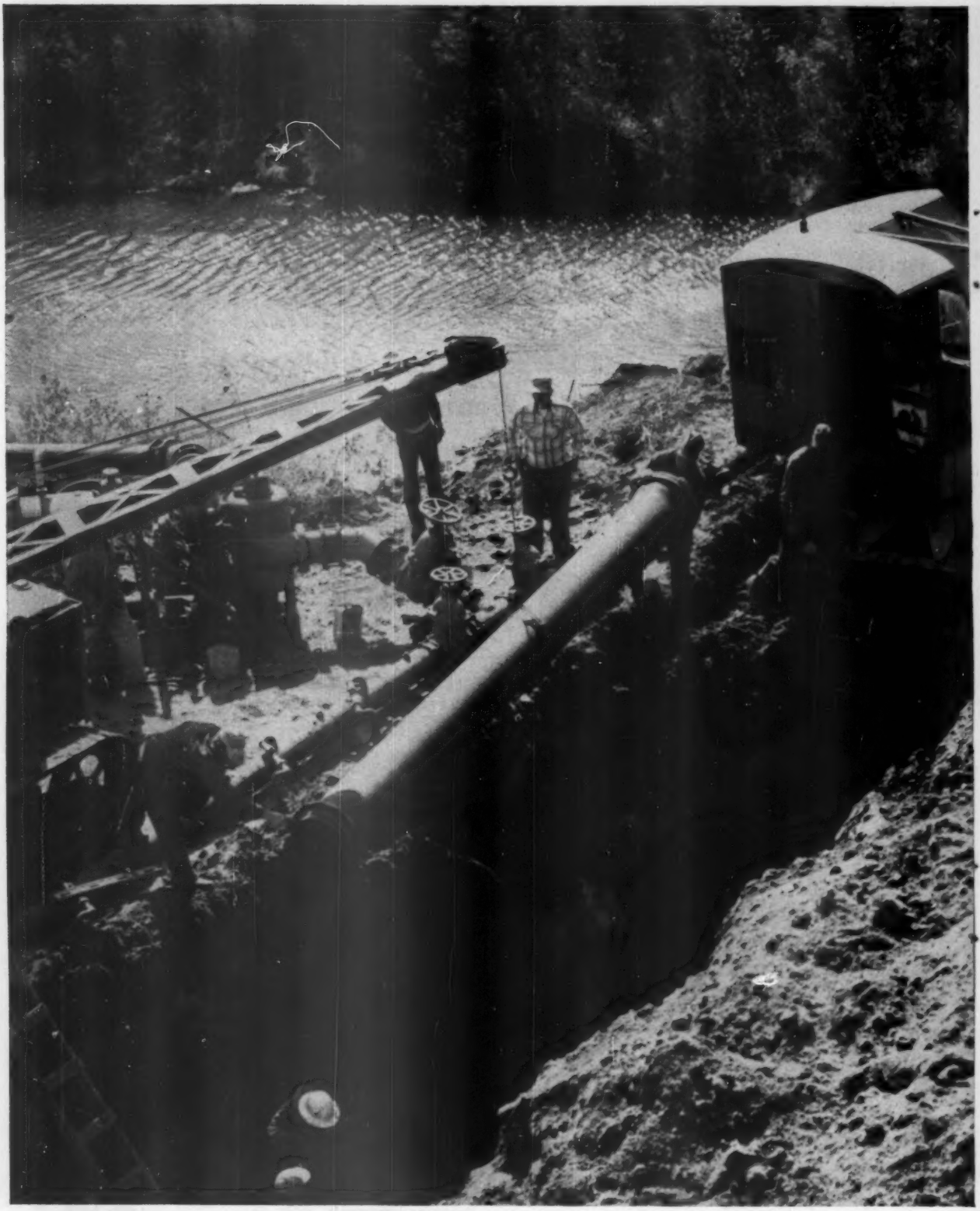
Simple, ingenious lugs in the frame casting pivot the lid and support it. Thus, if desired, it can also be completely lifted off.

For more information, write . . .

FOR BETTER WATER SERVICES

FORD

THE FORD METER BOX COMPANY, INC. Wabash, Indiana



WILL PERFORM FOR A CENTURY WITH A RIVER ON ITS BACK

At left, you see a length of cast iron pipe being installed under the Floyd River in Iowa. This is part of a water feeder main which will reinforce the existing water supply system.

Despite the severe conditions of a river overhead, the inherent ruggedness of cast iron pipe promises at least a century of trouble-free performance, and rarely requires repairs or replacement.

And cast iron pipe's cement lining assures a continued full flow of water year after year. It's no wonder that more than 90% of the pipe used for water supply systems in our 50 largest cities is cast iron pipe!

CAST IRON PIPE RESEARCH ASSOCIATION,
Thos. F. Wolfe, Managing Director,
3440 Prudential Plaza, Chicago 1, Illinois

CAST IRON PIPE
THE MARK OF THE 100-YEAR PIPE

At Cincinnati's new Mill Creek sewage works,

Jeffrey Flocculators and Sludge Collectors

Only a third of the Jeffrey flocculation-settling system is visible in this construction photograph.

Taken two years ago, this airview shows the wide extent of this 122 mgd treatment plant. Consulting Engineers, Haven & Emerson of Cleveland and New York.

Flocculation and settling are handled here in the same tanks, training baffles being used to separate the two functions. Eight of these combination tanks provide detention in the flocculation zone for 30 minutes and in the settling zone for 90 minutes, or a total of 120 minutes of settling time without flocculation, based on a daily flow of 122 mgd.

Jeffrey sludge collectors are in each channel of the flocculation tanks, as well as in each channel of the settling tanks.

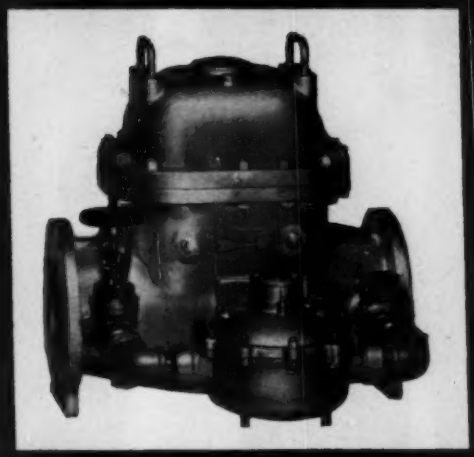
Behind the plans and equipment offered by the Jeffrey Sanitary Engineering Department are 65 years' experience in materials handling. This qualifies Jeffrey to offer complete technical information and apparatus on plant layout and machinery. The Jeffrey Manufacturing Company, 996 North Fourth Street, Columbus 16, Ohio.

JEFFREY

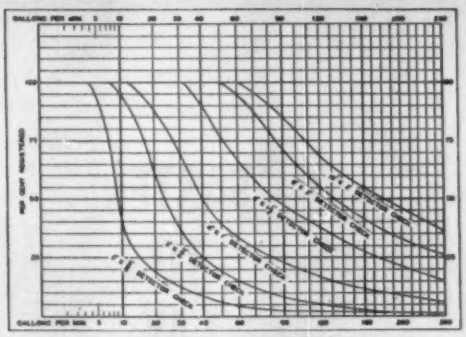
CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

HERSEY

Detect Leaks and Still Get Minimum Loss of Head Through Fire Protection Service Lines



Hersey Model DC (Detector Check) made in 2", 3", 4", 6", 8" & 10" sizes, equipped with a Hersey Disc Meter on the Bypass to indicate the use of water and measure accurately the lower rates of flow, will in case of necessity deliver automatically large volumes of water without obstruction.



PER CENT REGISTERED

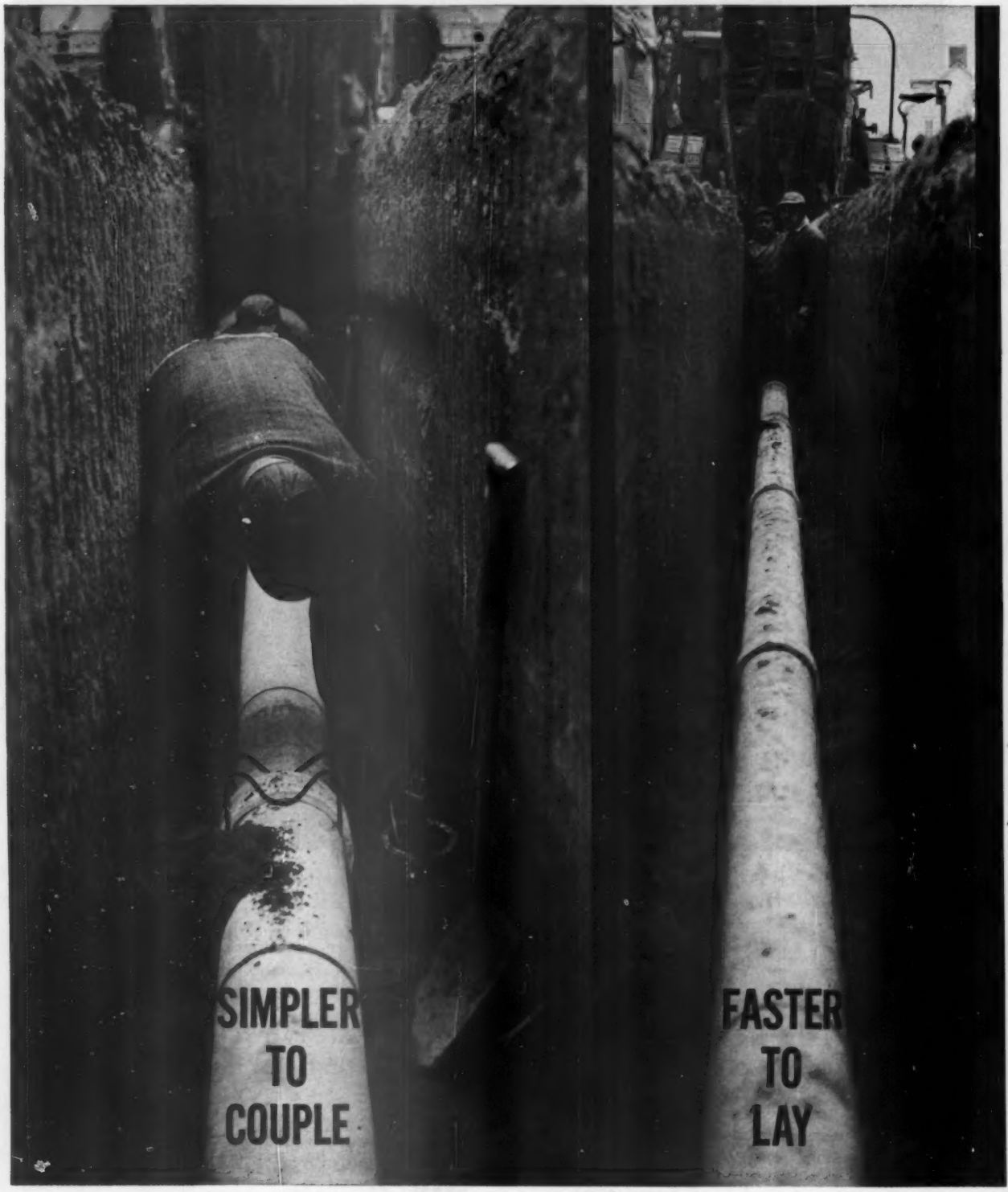
The loss of pressure through Hersey Detector Checks, at all rates of flow up to the full capacity of each size, is less than 4 pounds per square inch.

This device is designed to detect leakage or use of water from services which are intended to be exclusively for fire protection needs. Sizes from 3" to 10" are listed as standard under the re-examination service of Underwriters' Laboratories, Inc. and approved by Factory Mutual Laboratories for use in Factory Mutual insured properties, also listed by Underwriters' Laboratories of Canada.

Hersey-Sparling
Meter Company
HERSEY PRODUCTS
DEDHAM, MASSACHUSETTS

Branches: Atlanta, Boston, Chicago, Cleveland, Dallas, Denver, Kansas City, Mo., Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle.

"YOU'RE MONEY AHEAD WITH K·M BEST IN ASBESTOS



ASBESTOS-CEMENT SEWER PIPE!"

says prominent New Jersey contractor

. . . after laying more than 6 miles of "K&M" asbestos-cement sewer pipe

With the completion of the new sewer installation in New Jersey's thriving town of Marlton, Clyde Fear of Gray & Fear, contractors, had lots to say about "K&M" Asbestos-Cement Sewer Pipe. Here's what he told us. "You're money ahead with "K&M" Asbestos-Cement Sewer Pipe. Our men like the simple "K&M" couplings that slide in fast without any heavy machinery, and, believe us, that's one place where we save time and money. These simple coupling joints go miles faster. The pipe is easy to handle; there's less breakage on the job or in the storage yard. No lost time because of bad weather, either, because we can lay and couple this pipe in muddy trenches."

What Marlton, New Jersey, gained with "K&M" Asbestos-Cement Sewer Pipe, you can gain for your community, too. The pipe's smooth bore remains clean. This permits flatter grades . . . means fewer lift stations and lower pumping costs. It all adds up to less tax money for sewer installation and maintenance for your community.

Write today for more information on "K&M" Asbestos-Cement Sewer Pipe. Write to: *Keasbey & Mattison Company, Ambler, Pa., Dept. P-9120.*

FLUID-TITE COUPLING—an exclusive feature of "K&M" Asbestos-Cement Sewer Pipe. You simply lubricate the rings and slide in the pipe without heavy tools. The coupling is permanently tight, eliminates infiltration, and keeps out roots.

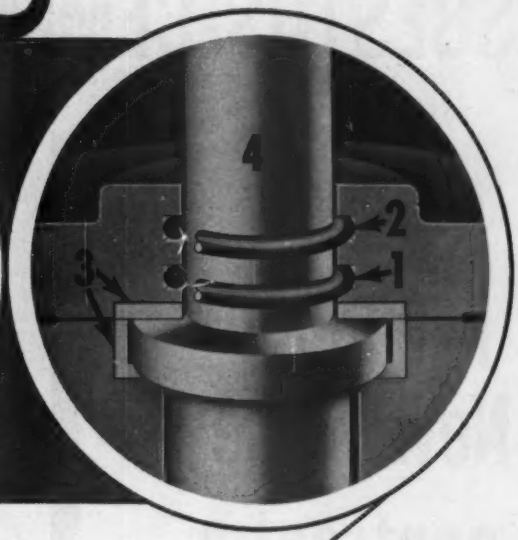
"K&M" Asbestos-Cement Sewer Pipe installation, Marlton, N. J.; Engineers: Sherman, Taylor & Sleeper, Merchantville, N. J.; Contractor: Gray & Fear, Woodbury, New Jersey.

Keasbey & Mattison at Ambler

Pipe plants at Ambler, Pa.—St. Louis, Mo.—Santa Clara, Cal.

ASBESTOS-CEMENT SEWER & PRESSURE PIPE

DOUBLE SEALING



SMITH VALVES WITH "O" RING SEALS

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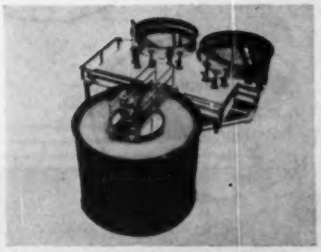

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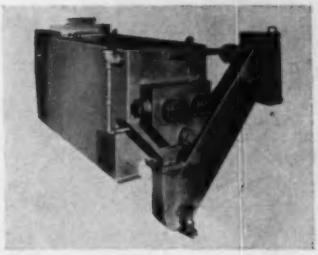

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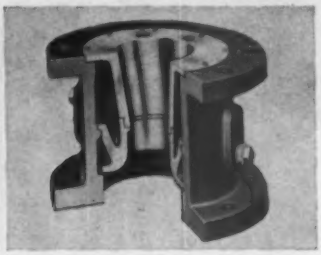

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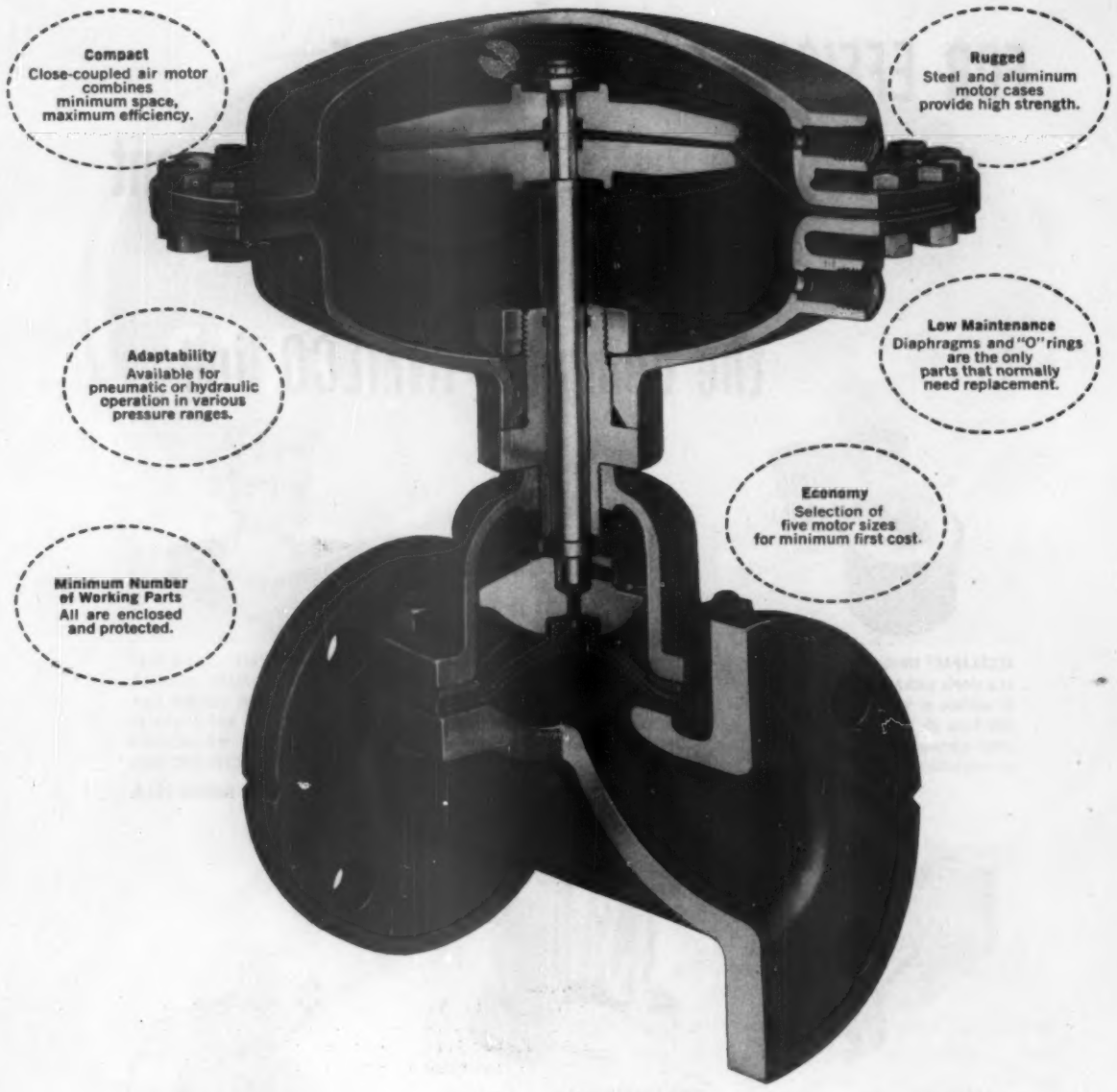
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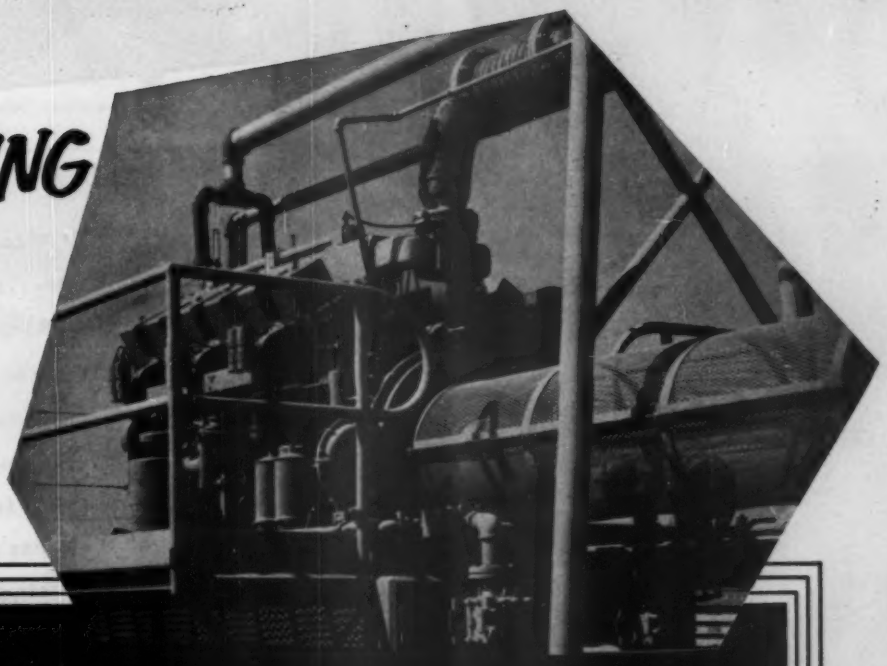

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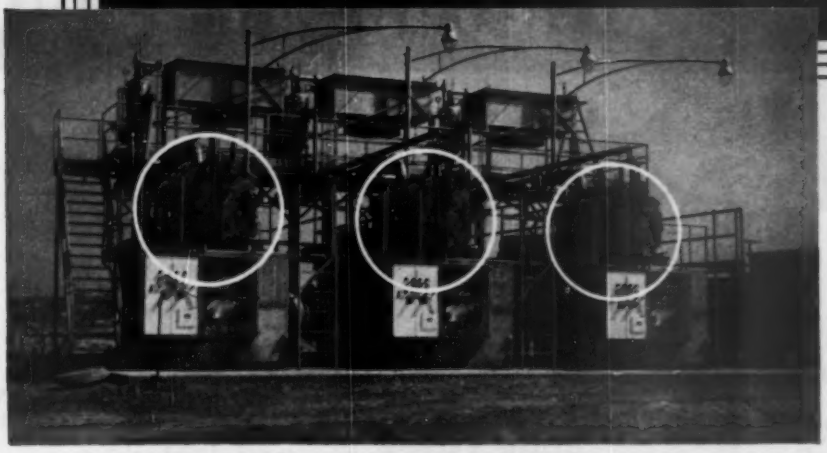
power outfall booster pumps



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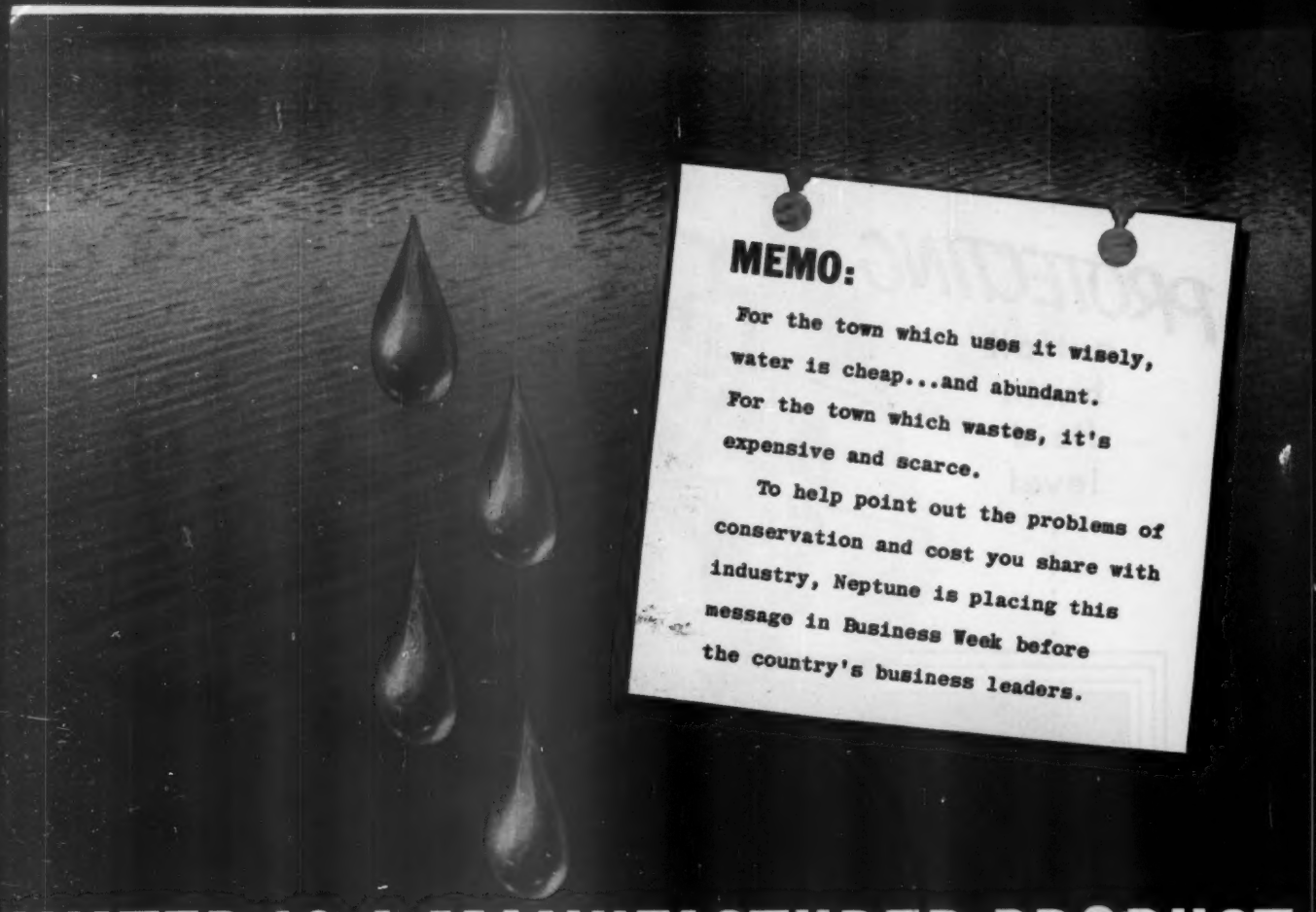
MEMO:
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But how do you keep your people from wasting it?

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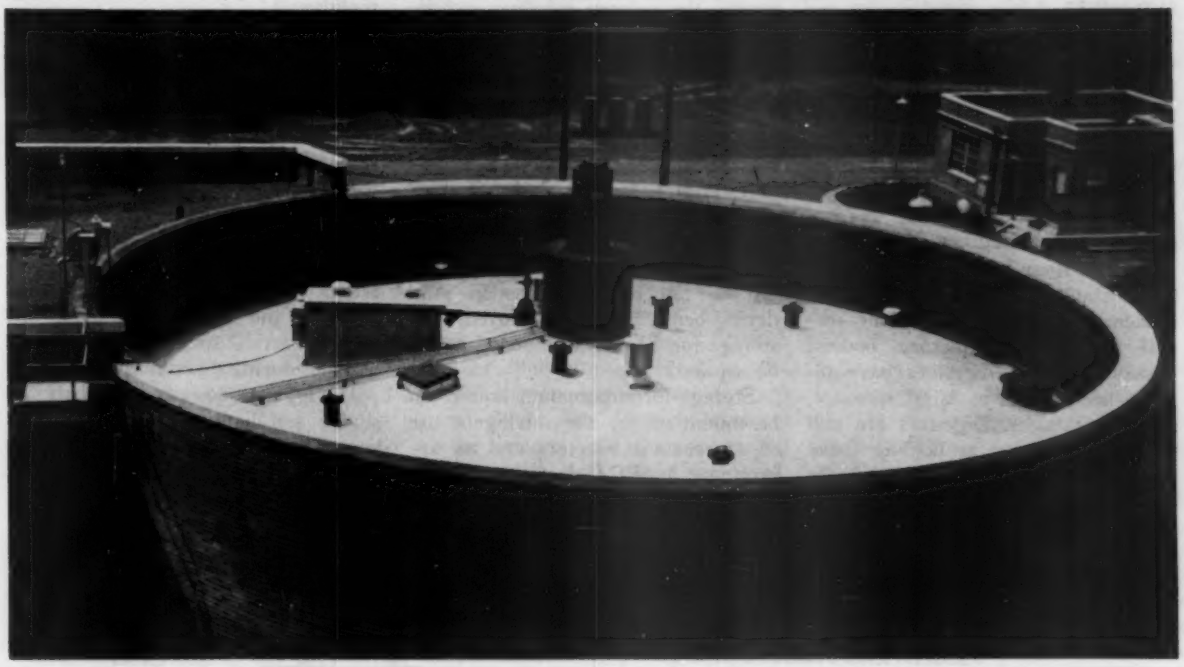

The efficiency of this digester is best discussed in terms of . . .

Digester Volume Requirements

by LEONARD L. LANGFORD
Eastern Sales Manager
Pacific Flush Tank Co.,
Port Chester, N. Y.

EDITOR'S NOTE: Digester volume requirements for municipal sewage sludge stabilization depend upon the use the volume of sludge is to serve and the effectiveness of this service. The volume requirement for a proposed facility is directly related to construction costs, and the efficient use of the volume provided is related to operating costs. The objective is, of course, to make these two costs as low as possible.

The author discusses the digester volume requirements including capacity for sludge storage, supernatant and actively digesting liquors. The advantages of a proprietary method of mixing which will allow for classification of bottom solids and excellent volatile solids reduction are discussed.

■ THE INCREASED EFFICIENCY of a biological process is only made possible by complying with the understood theoretical demands of the process. In the case of mesophilic digestion, an adequate supply of acceptable food must be made constantly available to the process organisms, the organisms must be maintained in a liquid media and a suitable temperature range of about 95 to 100°F must exist.

To meet these requirements or demands calls for rigid process control which has not always been available. Prior to 1925, solids reduction of sorts was obtained with no more control than is presently afforded by septic or Imhoff tank operation.

By 1926, John R. Downes had initiated the idea of maintaining a constantly positive digester gas pres-

sure by placing a floating cover in a separate sludge digestion tank. He also metered and used the process gas for heating the tank by means of a hot water heating coil, and he subsequently used the gas in engines.

By 1932, design development and promotion of the use of both floating covers and gas safety equipment established an important milestone in process efficiency—under conditions of safety. By 1946, the importance of close temperature control and its attainment, through the use of external sludge heating, had become generally recognized.

Despite these advances in the art, no substantial allowances in digester capacity were permitted by the several governing regulatory bodies; possibly because digesters have always been used, in large measure, as storage tanks. Digesters are still called upon to act as holding tanks for both the sludge-liquor and the bottom-solids which are awaiting further disposition. Thus exists the need for both digestion capacity and storage volume in a single vessel.

Computing Digester Size

As has been pointed out by Schlenz[1], in computing digester capacity, the volume requirements for digestion, sludge storage and supernatant should be computed separately. After determining volume requirements for digestion, additional cubage as may be required for sludge storage should be added to obtain digester size. If final sludge disposal includes the vacuum filtration of digested sludge, then 10 to 12 days storage might be considered adequate. On the other hand, if open sand drying beds are to be employed, then storage for 120 days, or more, might be required.

Storage for supernatant liquor can be minimized by the intelligent use of supernatant selectors and an appropriate type of discharge gauge.

Reducing the volume of the raw feed is also an important means of reducing digester volume. Use of devices of the type represented by the AccuRay unit of the Industrial Nucleonics Corporation, or a radioactive density meter for larger works, may very well develop into useful tools.

Use of a raw-sludge concentration tank, adequately equipped for liquor draw-off—and possibly having a simple aeration system for mixing the residuum, prior to transfer of sludge to a digester—could be a boon to small plants.

For larger works, gravity sludge thickeners for primary sludge, and air floatation devices for thickening activated sludge and mixtures of primary and activated sludge, are highly practical solutions to the problem of reducing digester volume.

Having winnowed the chaff of sludge and liquor storage from the kernel of solids-reduction, let us explore the possibilities of further increasing the capacity of a digester to do useful work.

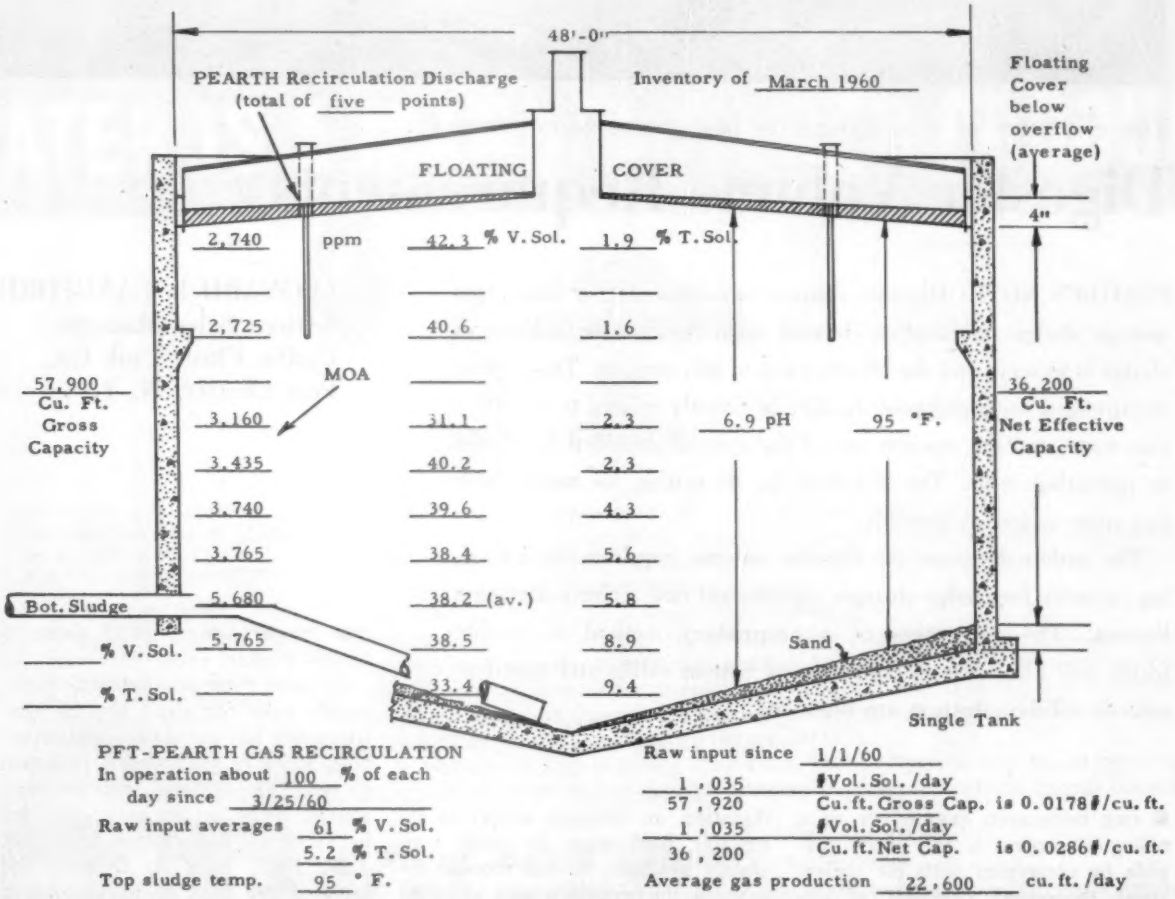

FIG. 1. INVENTORY of digester contents at the Somerset-Raritan, N. J., Joint Plant depicting solids classification.

TABLE 1.
Summary of Operating Results From Digesters Equipped With P.F.T.-Pearth Multipoint Gas Recirculation

Location	1. Number & Diameter Prim. Dig.	2. Year Initial Opera'n	3. Loading # Vol. per 1000 Cu. Ft./day	4. Average of Digester Contents Tot. Sol.	5. Average of Digester Contents Vol. Sol.	6. Average of Bottom-Solids Tot. Sol.	7. Average of Bottom-Solids Vol. Sol.	8. Reduction Vol. Sol.
1. Darien, Conn.	1-30'	1957	.0756	4.10%	51.7%	6.40%	45.7%	59%
2. Oxford, Pa.	1-30'	1957	.0807	4.18	65.3	5.70	54.0	73
3. Arlington Co., Va.	1-65'	1957	.2440	5.00	60.0	6.00	55.0	75
4. Wilmington, Del.	1-90'	1958	.1140	4.22	41.2	4.80	37.3	61
5. Hartford, Conn.	3-51'*	1958	.1750	4.46	58.0	6.30	46.1	63
6. State College, Pa.	1-50'	1959	.1540	3.63	63.4	3.90	54.2	72
7. Somerville, N. J.	1-48'	1959	.0200	4.43	39.9	8.30	37.8	63
8. Lehighton, Pa.	1-35'	1959	.0540	4.50	53.0	6.26	53.2	72
9. Upper Moreland-Hatboro, Pa.	1-50'	1959	.0652	3.36	49.7	4.31	48.6	44
AVERAGES	50'		.1092	4.21%	53.6%	5.77%	47.9%	67%

Plants:—1. Sludge is regularly drawn from Primary Digester directly to drying beds, quite satisfactorily.
2, 7, and 8 represent Single Digester installations.
9. Activated Sludge Plant . . . . with the Pearth System is able to obtain 4.31% Bottom-Solids for withdrawal. Supernatant liquor from secondary digester averages .20% solids.
* designates fixed roof tank.
BOTTOM-SOLIDS CLASSIFICATION is clearly indicated by a comparison of Columns Nos. 4 & 6, and Nos. 5 & 7.

Efficient Use of Capacity

Supplementing the previous observation with regard to the theoretical requirements of sludge digestion, it might be emphasized that it is necessary for the active portion of a digester to unite promiscuously into one mass or to become incorporated indiscriminately together, to quote uncommon definitions of the term "to become mixed."

Heretofore, mixing has been of a limited nature, resulting from recirculating by pumping through process piping or otherwise, or from such mixing as the rising gas particles might impart to the mass. Present practice, confined to the principal proprietary methods includes, among others, use of mechanical mixing by means of draft tubes, having ports located just above the bottom of the tank and operated by propeller action. Used in conjunction with sludge thickeners, continuous or incremental feeding of raw sludge of 5 to 12% solids are introduced into a tank, wherein the mixers are reported to be sized so as to pump the equivalent of the tank volume in approximately 40 minutes. Complete homogeneity of tank contents is reported to be the objective.

Another example of propeller mixing is represented by an unconfined flat-bladed turbine, consisting of straight vertical blades mounted on a straight circular plate, driven by a vertical shaft. This circular plate, passing through the blades and shaft, divides the circulator into two units. It is reported that the shorter blades in the upper part set up movement along the roof of the digester to prevent scum formation. Also, the lower portion imparts an upward spiral velocity to the tank contents at the center, with a corresponding downward current at the tank wall. Velocities equal to at least ½ foot per second are reported to be maintained in all parts of the digester, even along the bottom.

Present practice also includes the use of recirculated compressed sludge gas for tank mixing.

One of these methods is using volumes of gas of about 1 cfm per foot of tank diameter, through diffusers placed at the bottom-center of the tank. They are designed to diffuse over an area equal to approximately 1/100 of the tank surface area, thus creating an unconfined gas lift, which, it is claimed, will produce true homogeneity within the entire tank contents.

A second design of this general type is described as a circulator-mixer, employing the airlift principle. Gas, compressed to 6 or 7 psig, is released in the center of the digester through one, or as many as six, stainless steel, gas discharge pipes, at a point approximately 10 feet below the surface. The compressed gas is released within a tube, which extends into the lower third of the digester terminating at its upper end in a distribution head box, which is submerged about 2 feet. Sludge is pulled from the lower zone through the lift tube and, by such action, creating a roll of the entire tank contents, which, it is claimed, provides a digester turnover every 45 minutes. It is further reported that this time is reduced on high-rate digestion. Again, a homogenized digester mass is the objective.

The singular objective of both the mechanical and gas-lift methods, briefly described, is true homogeneity of the tank contents and/or high bottom velocities.

Another method, also employing gas recirculation, has as its objectives the classification of the bottom-solids, together with complete mixing of the "digesting" portion of a digester.

Classification of Sludge Solids

Pearth Gas Recirculation allows for violent agitation throughout the entire tank depth, when required. This was the requirement at Petersburg, Virginia, where an iron oxide waste caused a bottom-sludge build-up of as high as 30 per cent total solids. After the installation of gas recirculation, bottom-solids have averaged 7.6 per cent total solids.

When digesting a more typical municipal sludge, the use of multiple, automatically and sequentially operated 2 inch diameter plain end gas discharge pipes, terminating 10 to 12 ft below the sludge surface, prevents both reactional and thermal stratification. Classification, in terms of both volatile and total bottom-solids can be observed at all of the 130 Pearth equipped digester installations presently in operation, and as typified by a typical inventory of a single digester (Figure 1) at the Somerset—Raritan, N. J. Joint Plant.

Table 1 presents a summary of plant operational values which plainly illustrate the advantages to be obtained by so operating as to insure optimum bottom-solids classification.

Even in large tanks such as the 90 ft diameter primary digester at Wilmington, Delaware, monthly inventories always reveal bottom material having the lowest per cent of volatile and the highest per cent of total solids.

The facility of the solids classification method of digester operation derives from the fact that gas mixing need only be used for whatever period of time is currently required.

At Winchester, Virginia, for example, it is used in the primary digester during the canning season, once every three weeks; at other times, only once every six weeks. It is also used about four times a year in the secondary digester, from which an excellent quality liquor is drawn through the supernatant selector. Again, at Lehighton, Pennsylvania, in a single digester, Pearth is used for about 33% of the time; this allows for obtaining a very satisfactory material through the supernatant selector.

At the University Park, State College, Pennsylvania installation, loadings are variable, because of seasonal academic activities; however, at a loading figure of 140 pounds volatile per day, per 1,000 cubic feet, or 140 pounds of volatile solids, per 1,000 cubic foot per day, a volatile solids reduction of about 68% is reported by Gifford[2]. He further reports that, as the result of the excellently classified bottom-solids, vacuum filtration of digested sludge has been reduced from every two weeks to every three weeks, since the installation of the PFT-Pearth Process, in August, 1959. The same advantage has been indicated by Ford[3] at the Hatboro-Upper Moreland, Pennsylvania, activated sludge plant.

Summary

From the evidence considered, it would appear that digester volume requirements can be more accurately determined than heretofore. Also, that they can be reduced, to the extent that consideration is given to practical control of digester heating; raw-feed concentration; controlled supernatant removal and a flexible method of mixing which will allow for bottom-solids classification. When the latter is obtained, it will be found that the detention period of such bottom-solids is equal to or greater than the displacement period of the tank. This may well account for the excellent record of solids reduction which is reported from plants operated in this manner.

A recent study by Estrada[4], involving a comparison of the different methods of mixing in digesters provides additional information on the design criteria and factors affecting digester volume requirements.

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1. Schlenz, Harry E., President, Pacific Flush Tank Company, in private communication.
2. Gifford, David R., Chief Utilities Engineer, Dept. of Maintenance & Utilities, The Pennsylvania State University, University Park, Pa., in private communication.
3. Ford, Chester, Supt., Hatboro-Upper Moreland Sewage Treatment Plant, in private communication.
4. Estrada, Alfred A., Vice President, Albright & Friel, Inc., C. E., Philadelphia, Pa., "Design & Cost Considerations in the Use of High Rate Sludge Digestion", *Journal San Eng. Div.* ASCE, 86:SA3:111 (May, 1960).

Water Pollution Delays Checked by Pennsylvania

Municipalities must match industries in cleaning up water pollution, according to Dr. Charles L. Wilbar, Pennsylvania State health secretary and chairman of the Sanitary Water Board. Dr. Wilbar, reporting on a field inspection trip made recently by board members to eastern Pennsylvania areas, warned that "delaying tactics will no longer be tolerated by communities or industries that have failed to live up to their obligations under the Clean Streams law."

The city of Wilkes-Barre, against which legal proceedings are now pending for its failure to build a sewage treatment plant, was specifically mentioned. "Wilkes-Barre must act soon if it wishes to avoid further penalties for not treating its sewage as ordered by the board."

Board members during the trip watched raw sewage flowing into the Susquehanna at a sewer outfall beneath the Market Street bridge in Wilkes-Barre. The estimated 15 million gallons of untreated sewage daily emptied into the river from Wilkes-Barre city sewers is a major source of pollution of the Susquehanna.

Among the "further penalties" facing the city, Dr. Wilbar declared, are "additional legal actions and the rise in construction costs with each additional year's delay in treating its sewage."

The board visited waste treatment installations at the Rohn & Haas chemical plant near Bristol, toured the multi-million dollar Torresdale "push-button" water treatment plant of the Philadelphia Water Department and inspected the Northeast sewage treatment plant in Philadelphia.

Dr. Wilbar took occasion to compliment Bethlehem Steel and Rohm & Haas for "the steps they have taken to treat their industrial wastes."

Reservoir Proposed for Northeast Missouri

The authorization of a proposed $55 million Joanna Reservoir as a multi-purpose project on the Salt River in northeast Missouri was recently recommended by U. S. Army Engineers.

The recommendation came in a report by the St. Louis District Engineer and the Lower Mississippi Valley Division Engineer at Vicksburg, Miss., submitted for review to the Board of Engineers for Rivers and Harbors in Washington, D. C. The Engineers said that the reservoir could be used for flood control, power, navigation water supply, recreation, and fish and wildlife conservation.

In addition, the project would provide flood protection to 27,500 acres of land in the Salt River basin, reduce floods in the upper, middle and lower Mississippi River, and provide an annual generation of almost 49,000,000 kilowatt hours of electric power.

The reservoir also would provide a source of water to meet anticipated future municipal and industrial water needs, as well as attract a large number of tourists. Under their recommendations, provision would be made to permit installation of a second generating unit if warranted by economic conditions.

The report said local interests would be required to contribute 24.53 per cent of estimated initial construction cost of more than $55.8 million for the Joanna Reservoir, plus 10.79 per cent of the annual maintenance and operation cost.

An improved method is proposed for the . . .

Colorimetric Determination *of* Chlorine Dioxide in Water

by A. T. PALIN, Chief Chemist
Newcastle and Gateshead Water Co.,
Throckley, Newcastle upon Tyne,
England

EDITOR'S NOTE: The presently accepted methods for determination of chlorine dioxide are mostly applications of methods for the determination of chlorine. As a result, they do not differentiate between chlorine dioxide and other sources of chlorine in solutions which contain mixtures of materials used for chlorination. In this paper, the author describes a method he has developed that can be used to determine the relative quantities of chlorine dioxide, chlorine, and chloramines in a mixture of these materials. The basis for this determination is the Palin Method for Differential Titration for Free Chlorine, Monochloramine and Dichloramine which is given in the current edition of Standard Methods as a tentative method.

■ THE DPD METHOD for determining chlorine and chloramines in water may also be used to determine chlorine dioxide. In colorimetric methods so far suggested for this determination, for example that using ortho-tolidine, only about one-fifth of the total available chlorine appears to respond so that the methods are consequently lacking in sensitivity.

The fraction that appears in this way actually corresponds to the change from chlorine dioxide to the chlorite ion. Ingols[1] has already drawn attention to the fact that in the author's first differential titration procedure for chlorine and chloramines, which uses neutral ortho-tolidine as indicator, this change is included in the first step of the technique; that is in the fraction normally corresponding to free chlorine. The same effect is observed in the more recent DPD procedure which uses diethyl-p-phenylene diamine as indicator instead of ortho-tolidine and which, incidentally, has the advantages of more stable colors, fewer reagents and full response from dichloramine in neutral solution. This new procedure gives chlorine, monochloramine, dichloramine and, where necessary, nitrogen trichloride, (Palin[2]).

Method

Using the DPD indicator, a full response may be obtained from chlorine dioxide if the sample is first acidified in the presence of potassium iodide and subsequently brought to an approximately neutral pH by adding sodium bicarbonate. The color so obtained corresponds to the total available chlorine content of this compound. It is, therefore, a simple matter to devise a procedure for its determination using the DPD test solutions, the preparation of which is shown in Table 1.

Five ml. of each solution are used per 100 ml of sample. As these reagents are now available combined together in the form of a stable powder this, because of its greater convenience, is used in the procedure outlined below.

Determination of Chlorine Dioxide

To 100 ml of sample add a few crystals of KI and 1 ml of 5 per cent v/v H_2SO_4. After mixing and standing 1 min. to ensure complete reaction add about 0.5 g DPD powder and 4 ml of 5 per cent $NaHCO_3$ solution and again mix. Titrate any red color with stand-

Table I
Preparation of Solutions

1. Dissolve 0.1 g DPD oxalate or 0.15 g DPD sulfate ($NH_2\ C_6H_4\ N(C_2H_5)_2\ H_2SO_4\ 5H_2O$) in chlorine-free distilled water to which 2 ml of 10 per cent (by volume) sulfuric acid and 2.5 ml. of 0.8 per cent disodium ethylenediamine tetraacetate dihydrate (EDTA) have been added. Make up to 100 ml, store in an amber bottle, and discard when discolored.
2. Dissolve 2.4 anhydrous disodium hydrogen phosphate and 4.6 g potassium dihydrogen phosphate in distilled water. Add 10 ml. 0.8 per cent EDTA solution and make up to 100 ml. Add 20 ppm mercuric chloride if necessary, for prevention of mold growth.

Table 2

Amount of Sodium Chlorite Interference

Total Sodium Chlorite ppm available chlorine	Amounts appearing in DPD Procedure Step 1	Step 2	Step 3
1.10	0.00	0.00	0.03
2.20	0.00	0.01	0.05
3.53	0.00	0.02	0.19
4.51	0.00	0.03	0.27

ard FAS solution to a colorless end point. Alternatively match the colors against the permanent standard color glasses.*

Determination of Chloride Dioxide, Free Chlorine and Chloramines

As already noted chlorine dioxide appears with free chlorine in the first fraction of the normal DPD procedure but only to the extent of one-fifth of its available chlorine content. Since this corresponds to the change from chlorine dioxide to chlorite, it was necessary to determine the extent of any interference in the second and third fractions of the procedure; that is, monochloramine and dichloramine respectively, due to the presence of chlorite in the system at this stage. To investigate this the behaviour of solutions of sodium chlorite in the normal chlorine-chloramines procedure was studied with the following results. The figures given for total sodium chlorite are those obtained by applying the above acid-KI technique.

It seems evident that following the first stage reaction in the DPD procedure the sodium chlorite derived from the amounts of chlorine dioxide likely to be encountered in practice is without significant effect upon the subsequent determination of monochloramine and dichoramine. Accordingly it is possible to set down a simple procedure for the determination of a mixture of chlorine dioxide, free chlorine, monochloramine and dichloramine upon the following basis.

Normal DPD method gives
(1) Cl_2 + ⅕ ClO_2 (2) NH_2Cl (3) $NHCl_2$

Acid modification gives
$Cl_2 + ClO_2 + NH_2Cl + NHCl_2$

The difference in the respective totals gives four-fifths of the ClO_2 content from which a correction may be applied to the normal step (1) result to get free chlorine.

The first procedure, therefore, would be the same as that given above for ClO_2 except that in the presence of chlorine and chloramines the figure now obtained corresponds to the total available chlorine content. To a second 100 ml of sample add approximately 0.5 g DPD powder, mix and titrate any red color with FAS solution to get Cl_2 plus one-fifth of the ClO_2 present. Add a small crystal of KI and titrate any further color to get $NHCl_2$. Then add 0.5 to 1 g of KI and stand 2 min. to get $NHCl_2$. Deducting the sum of these fractions from the figure obtained for total available chlorine using the acid modification gives four-fifths ClO_2.

The calculations required to obtain the separate amounts of Cl_2, ClO_2, NH_2Cl and $NHCl_2$ are quite simple. In systems where only Cl_2 and ClO_2 are likely to be present, the second and third fractions of the normal DPD method may be omitted when the proposed procedure and the necessary calculations become even simpler.

When using commercial colorimeters and comparators it has been found convenient, especially in the field, to use reagents in the form of standardized tablets*.

*Available from Tintometer Ltd., Salisbury, England.

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*Available from Messrs. Houseman & Thompson Ltd., Burnham, England or from The Thermidaire Corporation Ltd., Toronto, 5.

Ramsey Named to AWWA Post

James B. Ramsey, formerly Chief Engineer and Superintendent of the Kansas City, Mo., Water Department, has been appointed Assistant Secretary of the AWWA. Mr. Ramsey assumed his duties, which include engineering and administrative phases of the Association's activities, on September 12, 1960.

Prior to his 20-year service with the Kansas City Water Department, Mr. Ramsey was associated with the Burns and McDonnell Engineering Company and the consulting firm of Howard, Needles, Tammen and Bergendoff, both of Kansas City. He is a member of the ASCE, the Kansas City Engineers Club, and has been an officer of both the Missouri Section of the AWWA and the Missouri Water and Sewage Conference.

Mr. Ramsey has been honored with the "Award of Merit" of the Missouri Water and Sewage Conference in 1957. In 1959, he received the Fuller Award by the Missouri Section of the AWWA. and in 1958 was Chairman of the Water Distribution Division of the AWWA.

German Course on Pollution Biology

An introductory course on the "Biology of Sewage and Stream Sanitation" will be held March 6-10, 1961, at Munich, Germany, by the Bayerische Biologische Versuchsanstalt (Demoll-Hofer Institut) under the direction of Professor Dr. H. Liebmann.

The Course is designed to acquaint the participants with the special problems of the biology of sewage and pollution control by means of class discussions and by microscopical training practice with different sampling devices.

Registration fees for all courses are DM 70 (about $18.00). Reservations for the Spring Course should be received by February 28, 1961, and should be sent to: Prof. Dr. H. Liebmann, Bayerische Biologische Versuchsanstalt, Munich 22, Veterinarstr. 13; transfer of fee to Postscheckamt Munich, Account No. 66550 of Prof. Dr. H. Liebmann. A program will be forwarded to each participant upon being registered.

A report of the latest research work investigating the effects of . . .

Household Detergents in Water and Sewage

by P. J. WEAVER
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Cincinnati, Ohio and
Member, Research Steering Committee
Association of American Soap
& Glycerine Products, Inc.

EDITOR'S NOTE: There is probably no other material that in recent years has been the subject of as much research and discussion as synthetic detergents. Much of this research work has been sponsored by the Association of American Soap & Glycerine Producers who have now or have had projects at many universities where sanitary engineering is taught. In this paper, originally presented at the 7th Ontario Industrial Waste Conference (Honey Harbour) and published with permission, the author reviews the highlights of the research work now in progress. This work has ranged from studies of the phosphorous content of an Illinois river to the bacterial degradation of alkyl benzene sulfonate. Of special interest is the work on foaming.

■ BY DEFINITION, A DETERGENT is anything that cleanses. As such, ordinary soaps, the new "synthetic" detergents, plain water, even sand when used for scrubbing, can all be classified as detergents. What really is of interest, however, are the synthetic detergents which have become so popular since World War II, and how these relatively new materials compare with the soap products which the housewife has used for years. The following simplified comparison between the two types of product may help to point up the similarities between the two, and make them both more understandable.

In Fig 1, which shows a representation of the two major types of packaged household washing products which the housewife might purchase, both the "synthetic" and the "soap" products are labelled as "detergents". Definite points of similarity exist between the two, in that the large proportion of each contains a surface active agent and a phosphate builder. The surface active agents, or surfactants as they are also called, differ between the two, as does the exact chemical identity of the phosphates. Also, the amounts or per cents of each are obviously different. Nevertheless, in the broad sense they both contain the same basic types of materials which, when properly formulated, combine to get out the dirt.

The next concept is very important to understand, because a misunderstanding frequently leads to misleading reporting of results. After a packaged product, either soap or synthetic detergent, is used for laundering, and released down the drain, it loses its individual brand identity, and must be considered on the basis of the individual components; i.e., the "surfactant" portion and the "builder" portion. Different manufacturers market different formulations in terms of per cent of individual components, but the chemical nature of the components themselves may be the same. Thus, once in water or sewage, only the components can be considered.

This is logical from the viewpoint of practical effect, too. For example, as will be brought out later, it is the surfactant portion of synthetic detergents which has been associated with frothing, not the phosphate builder portion. And the phosphates have been associated with algae growth, not the surfactants. Thus, they should always be considered separately.

In line with this, it is important that the components be named correctly, and it would be well to go on with the comparison of the packaged soap and synthetic detergents in order to make certain the terminology is completely understood.

The surfactant portion of either product is an organic agent which at laundering concentration lowers surface tension and penetrates between the soil particles and the cloth, thus helping to remove the soil when the fabric is agitated in the washing machine. It also is the material which makes the suds.

In the soap detergent the surfactant portion is called by the same name—soap, a name applied to it for many centuries before chemists finally identified its specific chemical structure. To be technical, it is the sodium or potassium salt of a fatty acid derived from a natural fat or

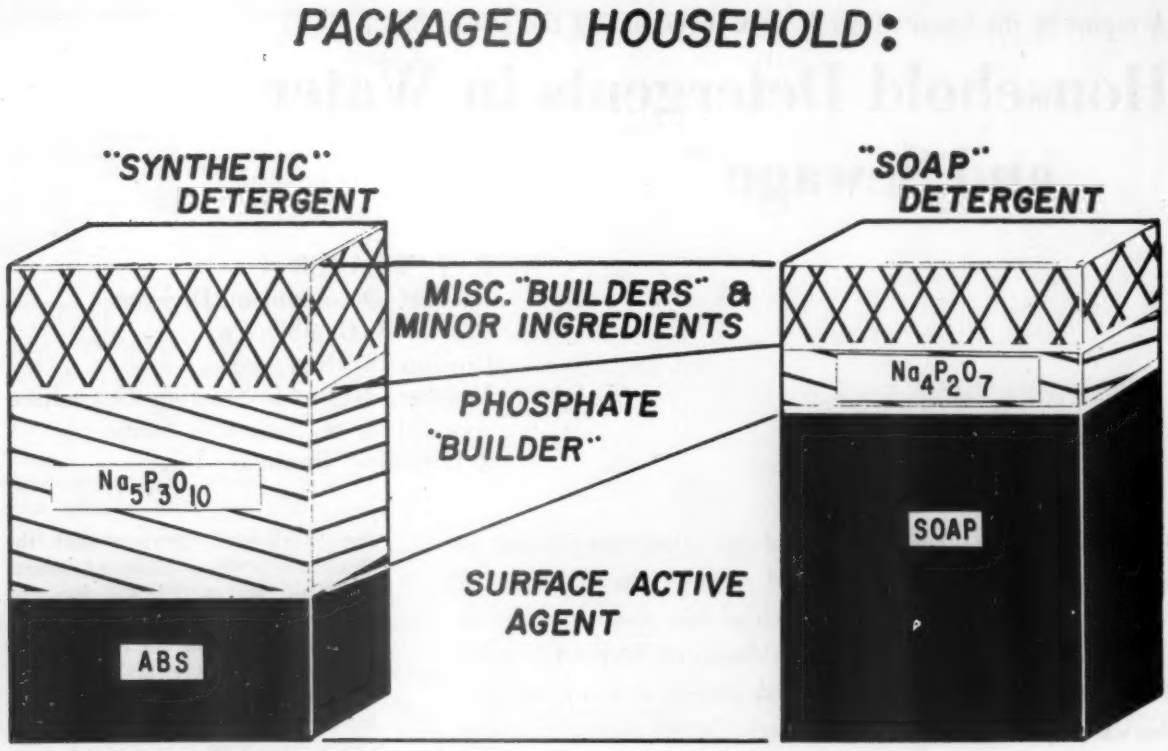

Fig 1 A REPRESENTATION of the two major types of packaged household washing products

oil. In the soap detergent this surfactant material may be as much as 90 per cent of the formulation. Thus, there isn't a great deal of difference in terms of per cent between the surfactant portion and the entire package soap product, and calling this surfactant "soap" does not lead to serious confusion.

In the synthetic detergent, however, as Fig 1 shows the surfactant portion is a much smaller per cent of the entire product than in the case of the packaged soap detergent. In this case to call this surfactant portion by the same name as the entire packaged product; i.e., "detergent" can lead to real confusion. This is a problem which has shown up many times in the literature, where persons may say detergent but actually mean surfactant, with the result that the interpretation of the reported findings is in error.

For clarity, therefore, it is strongly recommended that the terms "synthetic detergent", "detergent" or "syndet" be reserved for the complete packaged product; and the term "surfactant" or "surface active agent" be used for the organic sudsing agent. When this is done, the problem is automatically straightened out, and the reporting and interpreting of data are clarified. The specific surfactant material most widely used in household synthetic detergents, and which has been the subject of most of the U. S. research, is known as ABS, alkyl benzene sulfonate.

The phosphate builders present in both packaged household soap and synthetic detergents are mildly alkaline complex phosphates which, because of their soil suspending and hardness sequestering properties, help "build" the formulation into a product which will do the best job of getting dirt out of clothes. The specific phosphate compounds used in the packaged synthetic and soap detergents are not very different.

One interesting point which might be mentioned in passing is that in the U.S. the combined per capita consumption of packaged detergents and soaps has remained about the same during the years when detergents replaced soaps in the home. Total consumption, of course, has increased as the population increased. Actually, less surfactant from synthetic detergents enters the sewers today than did the surfactant "soap" thirteen years ago, because there is so much less surfactant in packaged detergents.

Analytical Aspects

Another point which merits a brief discussion deals with the analytical aspects of the detergent question. There are several methods available for the determination of ABS in water and sewage. The most widely used is the methylene blue colorimetric procedure, which was published in the October 1958 JAWWA[1] by the AWWA Task Group on Analytical Methods for ABS. However, as the Task Group cautions in its report, this method is subject to interferences, and at times can give misleading results. The Task Group therefore recommends that questionable results be checked by the referee procedure developed by the Soap Association[2] which is also included in the Task Group report. This method, based on infrared principles, is long, and consequently not normally used for routine checking. It definitely should be used if there is any question about results, however. Both of these methods recommended by the AWWA Task Group are expected to appear in the next issue of Standard Methods.

Improved methods for phosphates are also now available. A procedure developed by a Soap Association com-

mittee was published in the December 1958 issue of the JAWWA[3].

Algae Problems

The first of the two Canadian problems to be discussed is the question of algae growth. It is well known that some hold the opinion that phosphates derived from detergents have caused a significant increase in algal blooms. As it happens, the Soap Association has not sponsored any research on this particular problem, and thus it can only be discussed on the basis of what can be learned from the literature, and from talking with experts in the field. However, if nothing else, this review has established the fact that a good deal still needs to be earned about the causes of algal blooms, and it certainly would be preliminary to try to pinpoint these causes at this time.

A seminar on algae[4] was given in April 1960 at the Robert A. Taft Sanitary Engineering Center in Cincinnati which seems to support this position of uncertainty. For example, one speaker, Prof. H. K. Phinney, Oregon State College gave a paper on a problem which exists at Klamath Lake in Oregon. This lake receives essentially no domestic wastes, yet for over 60 years summer algal blooms have been intense. This is a case where natural enrichment causes the growth. Repeated chemical analyses of the water from many sampling stations failed to establish chemical factors which might explain the problem. The water was low in calcium, very low in dissolved phosphorus, high in chloride. Thus, very important sources of nutrients other than domestic sewage are definitely indicated.

Somewhat along the same line, another speaker at this seminar, Prof. R. O. Sylvester, Univ. of Washington, pointed up the extreme importance of drainage from forests and agricultural lands as sources of nutrients which can cause algae blooms. He presented data which showed that considerable amounts of both nitrogen and phosphorus result from run-off following rainfall, with agricultural lands showing the higher amounts, as would be expected.

Other interesting points brought up in this seminar included the statement by Dr. R. W. Krauss, Univ. of Maryland that so little is known concerning the nutritional requirements of algae, that even knowing the chemical makeup of waters, it is impossible to predict growth. At one point he also noted that polyphosphates are not suitable growth factors for algae. The types of phosphates used in detergents are, of course, polyphosphates.

Another speaker, Dr. Provasoli, Haskins Laboratory, noted that vitamins are required as growth factors with certain algae, and recommended that this factor be given increased attention. Still another speaker, Dr. G. W. Lawton, Univ. of Wisconsin reported that at the end of the first year of the diversion of domestic wastes around Wisconsin lakes, essentially no difference in the chemistry of the lake water is evident, although several new strains of algae have appeared. It is recognized, however, that this is a relatively short time in which to expect significant chemical charges.

All in all, the seminar pointed up the fact that a great deal needs to be learned before all of the factors controlling algal growth are known.

Still on the algae question, there are at least two additional literature references which bear on the question of phosphate contribution to algae growth. The work of Gerloff and Skoog at the University of Wisconsin[5] indicated that both the nitrogen and phosphorus contents of samples collected during periods of algae blooms in Wisconsin lakes were in the range of luxury consumption; in other words, they were very much higher than the minimum levels necessary for algal growth. The concentration of algae which might be considered a good lake bloom is quite low, approximately 10 mg of algae per liter.

Consequently, very low phosphorus concentrations apparently can support substantial blooms in natural waters. This raises questions as to the true significance of phosphorus derived from detergents, since without the detergent contribution sufficient phosphorus may already have been present from land drainage and other sources.

Also, there is some evidence that if the phosphorus content is increased beyond the minimum levels necessary to support good algal blooms, a heavier bloom does not result. Work by Dr. Fitzgerald at Wisconsin showed that there was no difference in the growth of one strain of algae, *Chlorella pyrenoidosa,* whether it was in an effluent containing 7.3 mg/l phosphorus or in the same effluent with three-quarters of the phosphorus removed; i.e., to 1.8 mg/l[6].

Although a great deal remains to be learned concerning the relative importance of the various nutrients, there does appear to be general agreement that regardless of source nitrogen and phosphorus are factors. Thus it would appear desirable to remove them, and one way which has been suggested is through use of oxidation ponds.

The review article by Fitzgerald and Rohlich on stabilization ponds[6] discusses the effectiveness of these ponds in removing nutrients. They report that ponds can achieve 75-90 per cent of reduction ammonia nitrogen, 60 per cent organic nitrogen and 96 per cent phosphorus. The phosphorus is believed to be precipitated out by the increased pH of the ponds, rather than removed by absorption by the algae. They point out that it might be possible to harvest the algae and sell it as a food supplement, chicken feed, or as a source of industrial raw materials. Harvesting, of course, would permanently remove any nutrient materials from the water which might be later released from dead algal cells.

Frothing Problems

The second of the two Canadian problems believed associated with detergents, or more accurately the surfactant material from detergents, is that of frothing on sewage treatment plants. In this area the Soap Association has sponsored some research, and it may be possible to provide more helpful information than in the case of algae. A project on the causes of frothing, and the means by which it can be eliminated or controlled, is being supported at the University of Wisconsin.

In many ways, this has been the most difficult of the various projects sponsored by the Association, because separating out, and even identifying, the various factors involved is a considerable problem. Some of these factors still haven't been established; however, much progress has been made.

To date the Wisconsin Project has established that while the surfactant ABS is one of the factors which contributes to frothing, many others, either independently or combined,

also are involved. For example, low suspended solids concentrations promote frothing, as has been recognized since the San Antonio studies a number of years ago.[7] Protein degradation products, present in almost every domestic sewage, also contribute to the frothing problem. In addition, elevated temperatures, over 70°F, and high pH values are somehow involved. Aeration rates play a role, and the conditions during low flow periods, particularly at night when ABS levels in the influent are certainly low, somehow promote the problem.

The degree to which each of these, and undoubtedly other, factors is contributing to frothing still has not been established. Nor is the actual mechanism known by which such materials as ABS and complex nitrogen compounds do contribute. It certainly isn't the simple matter of lowering surface tensions, because at the low concentrations of 10 mg/l or under the surface tensions are hardly affected. To our knowledge, no one has ever established a relationship between frothing and surface tension measurements in aeration tanks.

At present at Wisconsin they have designed a rather unique laboratory-scale continuous-flow activated sludge plant, Fig 2, in which an experiment is being run which will permit statistical interpretation of the factors being tested. These factors are 1. suspended solids, 2. detention period, 3. aeration rate, 4. ABS in feed, 5. BOD in feed, and 6. nitrogen: BOD ratios. High and low conditions or concentrations of each factor are included. A total of eight separate runs is required, and since each run requires as much as three to six weeks, and some have to be repeated, completing the study takes a long time.

It is not planned to submit the data to statistical analysis until the entire test is complete. However, it is interesting to note in passing that the incomplete results suggest that reduced frothing may be associated with lower aeration rates and extended detention periods. This cannot be considered conclusive at this time, however. Overall, it is hoped that out of this work may come the defining of operating conditions which will minimize frothing for the factors which exist and cannot be controlled, at any given time.

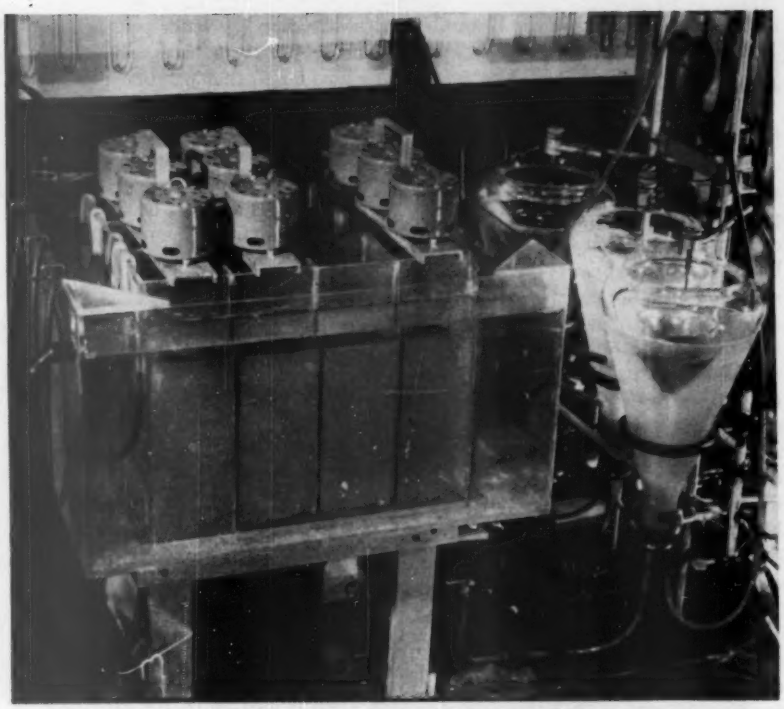

Fig 2 A LABORATORY SCALE experimental activated sludge unit developed to obtain data for the statistical analysis of the frothing problem

In general in the U.S. while frothing is recognized as a nuisance problem, it has not been generally associated with poorer plant performance. Operators keep it under control by maintaining high solids levels in the aeration tanks, or with sprays or defoamants. Much of the Wisconsin work has been published in *Sewage & Industrial Wastes*.[8]

Other Soap Association Research

It was mentioned earlier that the Association has supported other research in both the water and sewage treatment fields.

For example, projects at the Massachusetts Institute of Technology[9,10] and the University of California[11] have dealt with the fate of ABS in sewage treatment, and with attempts to improve the 50 per cent or better which currently is removed in primary and secondary treatment. The MIT people demonstrated up to 80 per cent removal on a laboratory basis with a complete mixing modification of the activated sludge principle; however, one attempt to modify an existing plant to this system has not yet been successful. The California people have demonstrated, also in the laboratory, as high as 90 per cent removal by deliberately frothing effluent from aeration tanks, followed by removal and separate disposal of this froth; this technique has yet to be applied to an operating plant. Both processes offer the promise of improved ABS removal if they can be adapted to large scale practice.

The area of water treatment has received considerable attention in the Association's research program. At Johns Hopkins University,[12] a project was carried out to determine effective and economic means for removing trace quantities of ABS from water supplies, should it ever become desirable. A number of materials which might serve as ABS adsorbing agents were evaluated, with activated carbon turning out to be the most effective. It was also found that different carbons have different effectiveness. It appears that, for ABS concentrations in the range of 0.2 to 2.0 mg/l, from 40 to 90 mg/l of a good carbon will remove 90 per cent of the ABS in the water supply.

It should be pointed out that, at least in the U.S., the levels of ABS in surface waters are very low, 0.5 mg/l and under.[13] The results of a weekly monitoring program which has been carried out since 1954 by Procter & Gamble on the Ohio River just below Cincinnati have shown an

average of only 0.16 mg/l apparent ABS, and there has been no tendency to increase during this entire period.[14] Similarly, two surveys of the drinking waters of 32 major U.S. cities serving an estimated population of 25 million have shown an average ABS content of 0.03 mg/l with samples ranging only from 0 to 0.14 mg/l.[15] These are certainly low, and insignificant levels.

The other Association project in the water area has dealt with the phosphate component of synthetic detergents, not as it relates to algae growth, but as this component might affect water treatment. This project was carried out at the University of Illinois. Studies were undertaken to 1. survey typical streams in the State of Illinois for the amount and type of phosphate present, and 2. determine whether the existing concentrations might have any effect on conventional water treatment operations. This latter phase stemmed from laboratory work which had suggested that the complex phosphates used in detergents could, at relatively high concentrations, interfere with coagulation and settling.

The survey of Illinois streams, using the improved phosphate analytical procedures developed by the Association, showed that phosphate concentrations were low, with the complex phosphates generally less than 0.5 mg/l as P_2O_5, and the ortho phosphate content about the same. It was also determined, and this is very important, that almost half of the total phosphate present comes from the drainage of agricultural land. This concurs with the findings reported at the algae seminar which were discussed earlier.

Laboratory studies on coagulation and settling showed that the 0.5 mg/l level of complex phosphates had an effect on this process which was barely perceptible, and that this could be overcome readily by either a moderate increase in coagulant dosage or an increase in settling time.

Other laboratory studies showed that the complex phosphates will degrade to the simple ortho form in the presence of stream biota, the rates of degradation varying according to the physical, chemical and biological conditions encountered.

Overall, the Illinois work showed conclusively that the phosphate levels found in Illinois streams have no practical significance on water treatment, and further that only a portion of the phosphates present can be detergent-derived.

The Illinois work has been published in four separate papers.[16] [17] [18] [19]

Safety of Synthetic Detergents

Questions are raised from time to time concerning the toxicological aspects of ABS, and occasionally, the polyphosphates.

The Soap Association has made a thorough review of the literature concerning ABS toxicity. This review, entitled *ABS and the Safety of Water Supplies,* has been published in the JAWWA.[20] The literature, covering acute and sub-acute toxicity experiments, shows in all cases an adequate factor of safety for ABS, considering the levels in water supplies.

In addition, a two-year chronic study of the effect of ABS in rats has been completed by Hazelton Laboratories and P&G, and has been published in *Toxicology and Applied Pharmacology.*[21] In this chronic study, levels of 1000 mg/l and 5000 mg/l were fed in the diet, and the weight equivalent of 1000 mg/l was fed in drinking water, to three different groups of rats. No evidence of toxicity was noted, and it was the conclusion of the authors that "to the extent that animal tests provide a basis for the assay of toxicity to humans, it would appear . . . . . that considerable amounts of ABS (much in excess of the amounts that might find their way into the drinking water) could be consumed over long periods without harm".

Of interest also are the limits being proposed for the current revisions of the U.S. Public Health Service Drinking Water Standards.[22] A limit of 0.5 mg/l ABS is proposed, based on aesthetic rather than safety reasons. The two reports mentioned above have been submitted to the Toxicology Subcommittee of the USPHS reviewing these Standards, and the fact that the ABS limit has been publicly proposed without toxicological comment suggests that they agree that the factor of safety demonstrated by the rat feeding experiments is more than adequate.

On the question of the safety of phosphates, the U.S. Food & Drug Administration has cleared both the polyphosphates used in detergents, and the ortho form to which polyphosphates degrade, for use as food additives.[23] This would appear to establish without question the safety of these materials.

Conclusions

This, then, briefly covers the activities of the Soap Association regarding the various questions raised in the U.S. on detergents and their role in water and sewage.

In general, it is believed the Association research program has shown that synthetic detergents are not responsible for all of the problems of which they were once accused.

The fact that ABS is removed to an appreciable extent in secondary sewage treatment has been established and methods for improving that removal in sewage treatment, as well as removing it from water, have been devised.

In aeration tank frothing, ABS is by no means the only contributor; in fact, the other factors are so important that merely by themselves they might create a definite problem.

ABS has been shown to have a toxicological factor of safety many times the concentrations which might occur in water supplies. Phosphates also are known to be safe.

Phosphates have been shown to cause no serious problems in water treatment plant operations.

The role played by phosphates derived from synthetic detergents in promulgating algae blooms is not clear. It is evident, however, that natural drainage from agricultural lands and forests can contribute significant amounts of nitrogen and phosphorus to streams and lakes, and these sources should be considered along with domestic wastes when studying specific problems.

In any event, the Association's broad research program is continuing, and as more facts are developed it is hoped that they can be used both to eliminate any problems where detergents are involved, and to further answer the many other problems of concern to the people in this extremely important field.

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EBMUD Sells Second Bond Issue

The second serial of its $252-million water development bond issue, in the amount of $30 million, was recently sold by the East Bay Municipal Utility District. The successful bidder for the Series B general obligation bonds was Halsey Stuart & Co., Inc. and Associates. There were two other bidders.

The syndicate headed by Halsey Stuart, a Chicago firm, was awarded the bond issue on the basis of a net interest rate of 3.30201 per cent.

Joseph A. Duner, EBMUD treasurer, termed the interest rate "very favorable." He noted that it was 15 points below the interest rate for the $25 million in Series A bonds sold in February, 1959. That rate was 3.4538 per cent. Halsey Stuart was the successful bidder on that issue also.

Other bids received on the $30 million issue were as follows: F. S. Smithers & Co., First Western Bank and Trust Co. and Associates; Net interest rate, 3.347034 per cent. Bank of America, National Trust and Savings Assn. and Associates; Net interest rate, 3.393075 per cent.

EBMUD's $252 million bond issue was authorized by the voters on June 3, 1958. It will finance the District's $283 million, ten-year expansion program aimed at meeting East Bay water needs through the year 2000. New and improved facilities to be finished in 1967 are approximately 25 per cent complete.

The district plans to issue portions of the $252 million issue annually through 1967 in accordance with the construction schedule.

Sea Water Conversion Plant Started

On August 30, Secretary of the Interior Frederick A. Seaton dedicated and formally broke ground for the construction of a 1 mgd sea water conversion plant, the first of five experimental facilities authorized by the Federal government. The ceremony took place at the plant's five-acre site close to the Gulf of Mexico at Freeport, Texas, which is some 60 miles south of Houston.

The pioneering conversion facility, built by Chicago Bridge & Iron Company, will produce potable water from the salty liquid of the Gulf of Mexico to serve the residents of Freeport and two nearby Dow Chemical Company plants. But more important to the Interior Department's Office of Saline Water, it will provide valuable data for the design of future installations.

Heart of the plant will be a multistage evaporator system, the first ever built to utilize 12 effects. As sea water moves through its dozen vertical vessels, each of which serves as a boiler for the next, above five per cent of the salty liquid will be converted to potable status. The remaining sea water will be returned to the Gulf of Mexico.

The design of the experimental processing system allows a high degree of flexibility for the testing of materials to combat anticipated corrosion and scaling within the unit. Eventual control of these two problems will be the key to low cost production of drinking water from the sea, according to conversion experts.

Actual construction of the Freeport plant was started on July 11. Contract specifications call for the facility to be placed in operation during the summer of 1961.

RESEARCH PROGRESS REPORT

Another W&SW research progress report about . . .

Toxicity Studies

on Cadmium and Hexavalent Chromium

. . . in Concentrations Which May Be Expected in Public Water Supplies

By RASHID A. ANWAR, CARL A. HOPPERT
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The Kedzie Chemical Laboratory
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RESUME: Toxicity of Cadmium and Hexavalent Chromium has been under study for about five years. Of particular concern are the small amounts probably present in public water supplies. Results to date of four year studies are reported here.

■ EXPERIMENTS to study the effect of prolonged ingestion of small quantities of cadmium and hexavalent chromium in the drinking water of rats and dogs have been in progress in our laboratory for approximately five years. These studies seemed pertinent because cadmium and hexavalent chromium have occurred in water used for human consumption in various parts of the world, largely through contamination by industrial wastes. Although the acute toxicity of these substances has been studied previously, no experiments to determine the effect of small quantities of cadmium and hexavalent chromium in concentrations which are occurring in drinking water have been made. It is hoped that the results of these studies will be useful in establishing a safe concentration of these substances for human consumption in the drinking water.

Cadmium.—An initial study with rats involved the feeding of cadmium for the period of one year. Separate groups of male and female rats of the Sprague-Dawley strain were given, *ad libitum*, distilled water containing 0.1, 0.5, 2.5, 5 and 10 parts per million (ppm) of cadmium (in the form of $CdCl_2$). Control animals were administered distilled water. All other conditions were the same for all the animals[1]. Some of the rats were sacrificed at the end of six months and the rest at the end of the year. During the period of this study no noticeable differences between the experimental groups and the control group were observed in water intake, food consumption or body weight. Nor did examination of blood and other tissues for pathological changes show any differences among the various groups and the control group. However, although no pathological changes were noted, the cadmium content of liver and kidney was found to increase in direct proportion to the concentration ingested. The tissue concentrations observed at the end of one year were roughly twice those seen at the end of six months.

Additional information on the absorption and distribution of cadmium in rats was gained by using radioactive cadmium (Cd^{115})[2]. Cd^{115} was administered both orally and intravenously to young adult male rats and, in both cases, practically all of the absorbed cadmium was found to be concentrated in liver and kidney. The quantity of cadmium, expressed as microgram per gm. wet weight of tissue, was higher in kidney than in liver, although the total quantity was greater in liver due to its larger weight. No cadmium could be detected in the urine throughout the course of this experiment (5 weeks). It was also observed that once cadmium gets into the liver and kidney, it stays there for relatively long periods of time.

Studies with Cd^{115} in the dog[3] showed that certain proteins in the liver have a greater affinity for cadmium than others; and these substances may therefore be a part of a detoxification mechanism whereby cadmium is removed from circulation so that it may not inhibit enzymes, especially enzymes containing sulfhydryl groups. The presence of such

cadmium-binding proteins may account for a certain amount of tolerance for this element.

In another experiment, dogs were given, *ad libitum*, drinking water containing 0.5, 2.5, 5.0 and 10 ppm cadmium (as $CdCl_2$), for four years and were sacrificed at the end of that period. There was a progressive increase in liver and kidney concentration of cadmium with the increase in concentration of cadmium in the drinking water [4]. However, the tissue concentrations in dogs receiving 10 ppm of cadmium were about the same as in dogs receiving 5 ppm. Some pathological changes have been observed microscopically in the kidneys and livers of dogs receiving 10 ppm of cadmium. The details of these observations will be published later.

The results of the various experiments carried out to date indicate that in the course of time cadmium accumulates in the liver and kidney tissue of animals, even when given in very small concentrations. This finding would suggest that prolonged ingestion of cadmium, even in small quantities, may lead to harmful effects, and in fact some pathological changes have been noted in dog liver and kidney after ingestion of water containing 10 ppm. Fortunately, cadmium carbonate is insoluble in both cold and hot water and as the normal water supply is usually quite rich in carbonate, cadmium when present in small concentrations should precipitate out and, therefore, be eliminated at the processing stage.

Chromium.—In order to determine the effect of ingestion of small quantities of hexavalent chromium in rats, males and females of the Sprague-Dawley strain were given, *ad libitum*, distilled water containing 1, 5, 10, 15, and 25 ppm chromate (as K_2CrO_4) [5]. Some of the animals were sacrificed at the end of six months and the rest at the end of one year. No toxic symptoms were observed in any of the groups during the course of this experiment. Microscopic examination of tissues did not show any significant pathological changes in any of the experimental groups. Analysis of tissues to determine the chromium concentration, showed that animals receiving approximately 8 ppm of CrO_4 or below, could excrete most of the chromate taken in [6]. But tissue retention was much higher when concentrations greater than 8 ppm were fed in the drinking water.

Absorption and distribution of chromium in the rat was further studied using radio-chromium (Cr^{51}) [7]. A single, orally administered solution containing 57 micrograms of chromium as $Na_2Cr^{51}O_4$ was absorbed to the extent of about 6% in fasted rats and about 3% non-fasted rats, as judged by the excretion of the administered chromium in urine. Hexavalent chromium was absorbed to a much greater extent than was trivalent chromium. Considerable reduction of chromate to the trivalent state occurred in the stomach and to a lesser extent in the intestine. Maximum content of radioactive chromium one day after administration of this material, occurred in the liver (about 1% of the total dose). All tissues studied, with the exception of spleen, showed a decreasing concentration of chromium with time.

Long term studies in which hexavalent chromium was fed to dogs were also carried out. Separate groups of dogs were given, *ad libitum*, drinking water containing 1, 5, 10, 15 and 25 ppm of chromate (as K_2CrO_4). The dogs were maintained on this regimen for four years and were sacrificed at the end of this period. The results of tissue analysis for total chromium showed that chromium concentration was higher in liver than in kidney or spleen [4]. The concentration of chromium in liver, kidney, and spleen was low and approximately the same in dogs getting chromate at all levels up to 15 ppm. There was an appreciable increase of chromium concentration in the liver of dogs getting 25 ppm of chromate. Examination of blood and other tissues for pathological changes revealed none at any of the levels of hexavalent chromium administered.

An interesting finding in both a one and two-year study in which chromate was fed to rats at different concentrations in the drinking water was that the rats receiving chromium had greater longevity than the controls. The reason for this fact was not immediately apparent.

Recently Schwarz and Mertz have shown that chromium is a glucose-tolerance factor in rats and may, therefore, be considered a physiological element [8]. In the light of our work and this recent finding, it would appear that chromate in low concentration has no deleterious effects upon rats and in fact may be necessary for proper functioning.

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Inventory of Research in Water Supply and Pollution Control

A "Research Inventory" summarizing data on 280 water supply and pollution control research projects active in the United States during 1958 has recently been issued by the Public Health Service. The publication is intended as a source of information on research projects in the field of water supply and pollution control for those administering and for those conducting research.

This 71-page booklet is divided into three main sections. The first is a listing of research projects by states, describing briefly where the project is located, what is being investigated, and who is directing the research. The second section is an extensive subject index arranged by research areas. The final section provides an address list of those reporting the projects listed.

A brief analysis of information contained in the project list is included. The research projects are largely conducted in universities: (73.2%) with the remainder being nearly equally divided between state, Federal, industrial and local agencies.

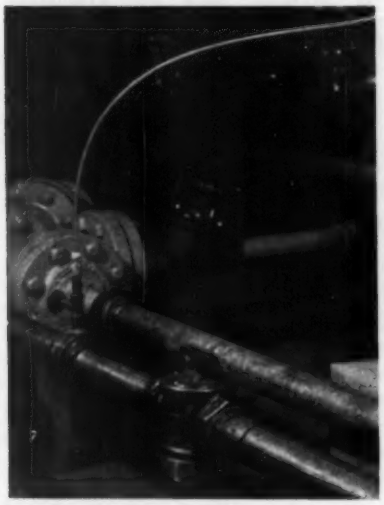
Copies of this publication are free upon request. Write to: Research Grants Coordinator, Division of Engineering Services, Public Health Service, Washington 25. D. C.

Exacting test procedures and precise equipment determine the . . .

Operating Results of Valve Design

A STAFF REPORT

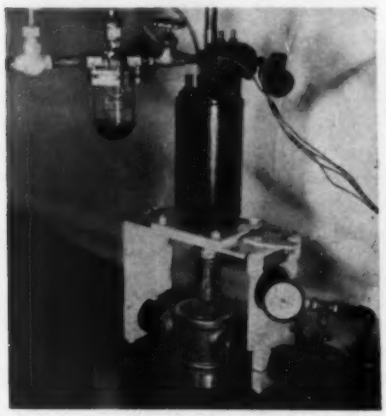
■ IN THIS FAST MOVING jet age, it becomes a virtual necessity for products to move directly from the drawing board into production. Any disruption of this procedure tends to make the product obsolete before it becomes available.



VALVE IN LINE under full rated pressure for pressure loss test.

Research, development and testing facilities utilized today by industry are a direct result of the demand for the rapid availability of more diversified, highly designed, guaranteed-result tools, machinery, and equipment.

Today these research, development and testing facilities have become as essential to the successful operation of a company as are qualified, efficient employees and up-to-date mass production techniques.



CYCLING TEST.

The many companies supplying the water and sewage works field today are probably more aware of these basic concepts than industry as a whole, because any product developed for the water and sewage works industry must have as its basic premise, smooth, trouble-free operation over a longer-than-normal life span.

For example, the Mueller Co. Decatur, Ill., one of the many progressive companies serving the field, has recently constructed a new building to house their research, development, testing and engineering division.

To illustrate the development and testing of a product before it is made available to the field, it might be of interest to follow the story of the new "Oriseal" curb valve.

The story could start back in the 1930's, when extensive experimental work was done on the use of coated keys, vulcanized rubber, etc., in the search for the ideal curb valve.

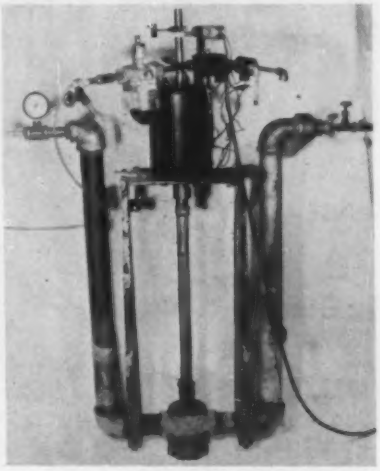
The first major break-through was the idea of using "O" rings in the valve. Although the use of "O" rings was not new, work on their adaptation to the curb valve was started early in 1943-44. First, hand-made models were developed, then an attempt was made to cast the grooves in the valve for the "O" rings. These models were redesigned, rebuilt and tested many times for over 6 years.

Work on the valves really got under way during 1948 with the acquisition of a special milling machine, again an example of other research and development of highly designed machinery, that enabled the milling of the "O" ring grooves in the valve body.

During the years when the valve was under development, it was constantly under many and varied tests. It was also during these years that the need for better and more extensive testing facilities became apparent. This resulted in the new large product testing and development laboratory.

Testing

In this new laboratory, engineers and testing technicians, equipped with the latest types of manual and electronic testing equipment, determined if the new valve was meeting design specifications and would stand up under the rugged conditions of field use.

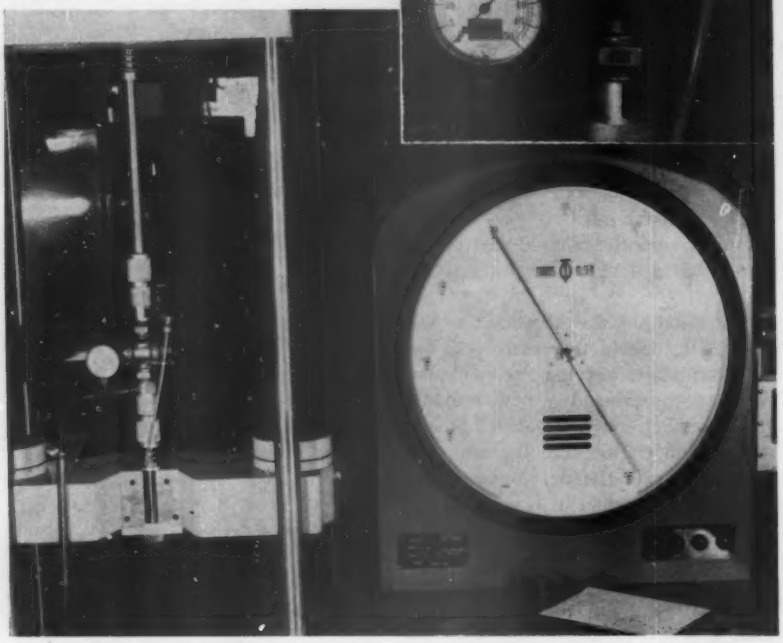


CYCLING TEST while submerged in abrasive solution of water, sand and grinding compound. Valve is under air pressure of 125 psi.

A specially designed high-pressure test room made possible the testing of the valve to destruction. The high-pressure room also provided facilities

TORSION TEST resulted in shut-off rod failing at 3,885 lbs. Valve is undamaged.

TENSILE TEST resulted in schedule 40 steel pipe breaking at threaded section at 14,140 lbs.



for the cycling tests under pressure.

Some testing machines are necessarily specially designed and custom built for the complex testing procedures employed by the company. An example is the special electronic instrument that measures taper, concavity, convexity, waviness, etc., of the valve and stop cock keys, bores, bodies, etc. This machine produces extremely accurate measurements up to one ten-millionth of an inch.

Of particular interest is the cycling series: machines are available to mechanically cycle the valve from fully-open to the fully-closed position and return. The valve was tested under water using compressed air at 125 psig. Many thousand cycles were run and counted. Frequent observations were made for leakage during the test. Another cycling test was conducted with the valve completely submerged in an abrasive solution of water, sand and grinding compound. Compressed air was again used in the valve during the test. Water was then used as the testing fluid, with the valve being cycled against the flow at pressures of up to 500 psig. This test is constantly checked for positive cut-off by means of an open pipe downstream.

The more conventional test machines and units put the valve through its paces with bending tests, compression loads, torques, tension tests, etc. Special electronic equipment, utilizing strain gages, provides highly accurate data for evaluation. Stress paints are extensively used through-out the testing cycles.

All tests are then evaluated by the engineering department. If evaluation and results raise a question or indicate a change in design, the change is made; then the product is completely retested, and results evaluated before being released to the field.

As part of the testing sequence, field tests, or actual installation operations play a major role. In the case of the "Oriseal" valve, a unit was placed in a plant where circumstances dictated it being left in the open position for a year. It was reported that this valve was easily turned off using a 12 in. wrench. Other field tests have reported that the valve closed easily after being left in the fully open position for 12 years, and in other cases an installation was subjected to over 45,000 cycles without adding grease or replacing "O" rings.

BENDING TESTS resulted in pipe failures with no damage or leaks occurring in valve.

STRESS & STRAIN analyses.

Results of Testing

As a result of the extensive testing program and research development, the company felt that the valve

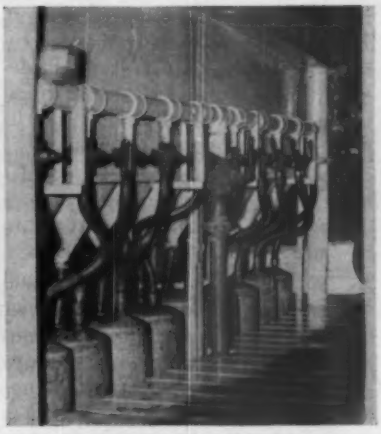
was ready for introduction to the water field. The engineers also pointed out that research and testing, resulting in the adaptation of the "O" rings in the valve, made it possible to use a straight key rather than a tapered key. The straight key equalizes pressure around the key, insuring sealability, and reducing torque necessary for operation. The use of the full port, rather than the tapered way, insures that the "O" ring will not be stretched or cut out of the groove. One of the main features, made possible for the first time by this development, is that the keys can now be interchanged without removing the valve from the ground or disconnecting the lines.

HYDROSTATIC BURST TEST showed some leakage at 2,000 psi, with fractures occurring at 2,400 psi.

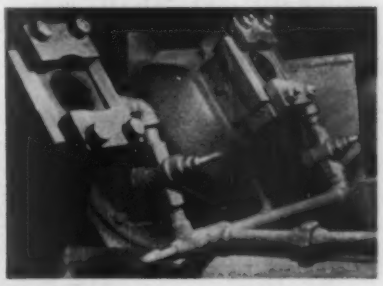
Conclusion

This article tells the story of one product made by one company, and can be multiplied many times by many companies now serving the water and sewage works field. However, it further points out that the demand is constantly growing for more and more of this type of procedure by more companies, if the water and sewage works field is to remain abreast of the rapidly increasing demands made upon it by both the growing population and expanding industry. In fact, more rapid development and adoption of new, adequately tested, equipment and materials for the industry should become one of the main objectives of the many suppliers of equipment, plant and supervisory personnel, and engineers working in this field.

EASE OF TURNING TEST showed on 15 lbs. of turning effort required for 2 in. valve under pressure of 125 psi with a flow of 150 gpm.



WATER SOFTENING PLANT—Some valves used daily, others only once a year, showed equal ease of turning.



FIELD TEST operation of 45000 cycles without adding grease to replacing O-rings.

Water wells in glacial drift may cost less and produce more using . . .

Reverse Circulation Drilling

by N. E. Gunderson
Layne-Northern Company
Mishawaka, Indiana

EDITOR'S NOTE: Improvements in water well drilling techniques do not occur very often. While reverse circulation drilling methods are not new, in fact some may consider them modifications of rotary procedures, there still remains the problem of tool standardization. If more water can be produced at less cost, reverse circulation drilling can make a substantial contribution to water production know-how.

■ REVERSE CIRCULATION drilling, applied principally to water wells in glacial drift, is a variation of rotary drilling used in the oil fields for a number of years. This newer method is particularly interesting because basic changes in well drilling methods occur infrequently.

Two principal motions can be applied to drilling tools at the surface of the ground. The first and oldest is the drop tool method used by the Chinese several thousand years ago. Tools and equipment have been improved, but basically it still consists of lifting and dropping a string of tools. There are definite limitations of depth, with the deepest hole being approximately 7,000 feet.

Rotary drilling first came into use about fifty years ago and opened up the Texas oil fields. The hole is drilled with a rotary motion of the tools and the hole is filled with fluid which holds the hole open during drilling. Holes have been drilled by rotary to approximately 20,000 feet. Rotary drilling is best adapted for deep, small diameter holes. In contrast, reverse circulation has only been in use about 20 years. Particularly adapted to large diameter water wells in glacial drift, the approximate maximum depth is 1000 feet. This method is properly named reverse circulation because the liquid is drawn up through the drill rods under vacuum while in the earlier rotary method the liquid was pumped down through the drill rods under pressure. In addition the main features of reverse circulation drilling are practically opposite to the features of rotary drilling.

Principle advantages of reverse circulation over rotary drilling are larger diameter wells at less cost and less power required for drilling. Compared with cable tool drilling, reverse circulation also provides larger diameter at less cost and an open hole in which material may be freely raised or lowered to correct position. Further, the well casing may be cemented from top to bottom, if desired. Wells drilled by reverse circulation show increased yield over wells drilled by cable tool or rotary.

Both rotary and reverse circulation drilling in glacial drift use a drilling fluid to carry the cuttings to the surface and to hold the hole open. In rotary drilling, the drilling fluid is usually a mud considerably heavier than water so that the hydraulic problems in handling underground water are almost eliminated. However, it is fairly common practice in reverse circulation drilling to use clear water for the fluid which provides an excess pressure to counterbalance the water in the formation outside the hole.

Discharge And Recharge Wells

In order to demonstrate the problems in this hydraulic balance, it will probably aid to consider first, an artesian discharge well and second, an artesian recharge well. A discharge well takes water out of a formation and a recharge well puts water back into a formation.

Consider the case of a well pumping from an artesian formation. The term artesian refers to a water-bearing formation full of water and that the formation has a clay cover. The static water level in any hole penetrating this formation will lie above the top of the formation. It is common practice to report a test of this type well by quoting the amount of water level decline for a given quantity of pumpage. This decline is called the drawdown. Pilot wells located at varying distances from the pumped

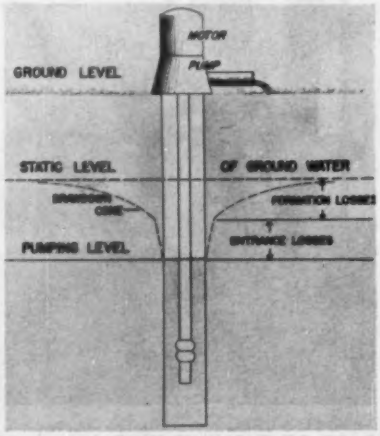


FIG. 1. DISCHARGE WELL showing drawdown cone and relationship between formation and entrance losses during pumping.

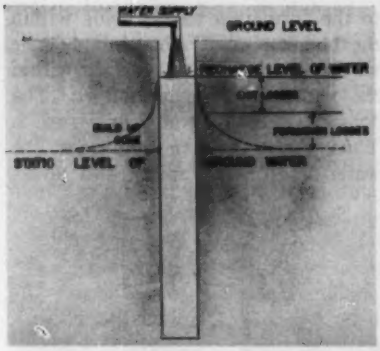


FIG. 2. RECHARGE WELL showing build-up cone and relationship between formation and entrance losses during recharging.

well would also have drawn down and the water level indicated by these pilots would assume the shape of an inverted cone. This is commonly called the drawdown cone, Figure 1, or cone of depression. The cone's shape is determined by the characteristics of the formation and is not affected by the type of well construction. The yield in gpm divided by the total drawdown input gives gallons per foot of drawdown, or specific yield of the well.

If the pump is removed from this same artesian well and water is poured into the well, an artesian recharge well is produced. The action of this recharge well should be, for all practical purposes, the reverse of the action of the discharge well. There has been very little discussion or standardization of terms on recharge wells so we might use the word take to express the gallons per minute of water added to the recharge well. The take in gpm divided by the build-up in feet gives the specific take of the well. The static level can be multiplied by the specific take to obtain the approximate flow of water required to fill the well and to keep it full.

If water is added to a recharge well at a constant rate, a cone will be built upwards instead of downwards as in the drawdown cone. For lack of a better term this may be called the build-up cone, Figure 2, as opposed to the drawdown cone. In the discharge well the drawdown cone and also the drawdown itself can very properly be divided in two parts. First is the drawdown cone due to the friction losses in the formation itself, which are practically independent of the well construction. Second, there is the portion of the drawdown and the drawdown cone which is due to the entrance losses into the well caused by friction in the screen and in the formation immediately surrounding the screen.

In the recharge well the feet of build-up or the height of the build-up cone can also be divided into two parts which consist of friction losses in the formation itself and exit loss due to the water flowing through the screen and through the formation immediately around the screen, as illustrated in Figure 3. Extremely important, this exit loss is the one factor making it possible to drill a hole and hold it open with clear water without using a well casing. If a completed artesian recharge well is kept in service, it would be possible theoretically to remove the casing and the wall of the hole would stand up indefinitely until the water supply was cut off.

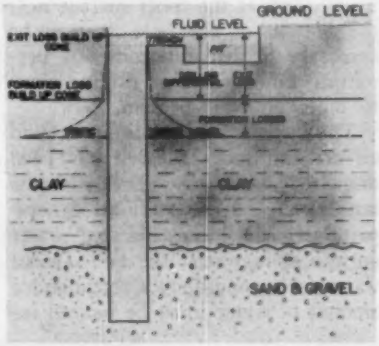


FIG. 3. HYDRAULIC CONDITIONS required during reverse circulation drilling. Fluid level in pit determines head required to hold well hole open.

The above examples describe how a fluid process can be used to hold a hole open if fluid is continuously supplied to the hole to maintain an internal pressure greater than the external pressure. Figure 4 illustrates a typical reverse circulation drilling system. The take or flow into such a well is actually leakage through the wall of the hole. A pit provided adjacent to the well will hold the water level at ground surface. The amount of water to provide this take in the well is usually considered as make-up water into the pit. Since the hole is full of fluid which holds the hole open, it is a very simple matter to pump the fluid into the hole or out of the hole and remove the cuttings from the bottom of the hole during drilling.

Planning Required

Drilling by this method requires considerable engineering planning. It is a basic contradiction that, while drilling, a watertight hole is desired, while after it is finished, a leaky hole is necessary to make a good water well. In planning a job of this kind an accurate test well is essential. An electric log helps to insure that the proper formation is developed and gives some indication of probable yield. The most important information can be obtained from a special pumping test which would give the static water level and the shape of the drawdown cone developed around the well. Such a test will enable prediction of the yield of the finished well and the probable take while drilling. It is necessary to have this information before starting work, because a high static level may indicate that the hole will collapse before it is finished. A low static level may demand such a large take that sufficient water supply may not be available.

As was stated above, the exit loss is the differential which holds the hole open. Exit loss would normally be expressed in feet and for a given exit loss there would be a definite take in gallons per minute. The exit loss or differential varies approximately as the square of the take in gallons per minute. The distance from the static level to the water level in the pit is the maximum water head available. This head will be spent in overcoming the exit loss and the formation loss. The formation loss

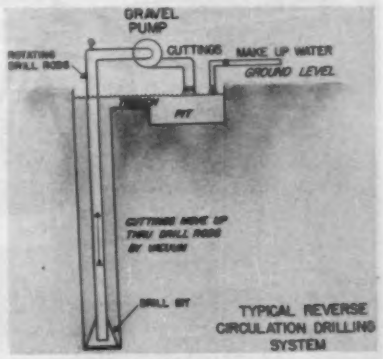


FIG. 4. SCHEMATIC ILLUSTRATION of typical reverse circulation drilling system. Note requirement for source of pit make up water.

is measured by the height to which the water level rises in the formation, just outside the bore hole. The difference between this height and the water level in the pit measures the exit loss which will keep the hole open.

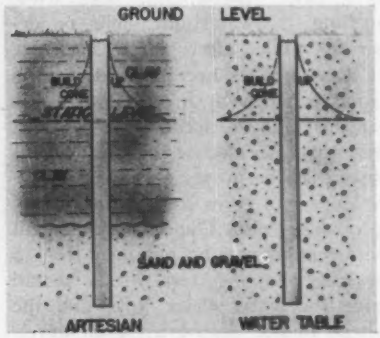


FIG. 5. COMPARISON OF build-up cones under artesian and water table conditions. Greater quantity of water is required to maintain build-up cone in water table.

Static Level

If nature provides sufficient height from static level to ground level, and a suitable formation to match, it may be possible to fill the hole with water and start drilling. However it may not be quite so simple and it is necessary to study the factors affecting this differential and learn how to control them effectively. The four possible factors are fluid height, fluid weight, fluid viscosity or flowability and wall friction. The fluid height can be increased by building up the ground surface or by operating a nearby dewatering well which would tend to pull the static level down at the spot where the well is to be drilled. Fluid weight can be controlled quite effectively with drilling clay since any required weight up to 15 or 16 pounds per gallon of drilling mud can be obtained. Fluid viscosity or flowability can be controlled in the same way by the addition of drilling clay and additives to obtain the desirable viscosity. Wall friction can be increased in several ways. The loose sand grains in the water while drilling tend to build up wall friction and the addition of drilling clays to the water builds up a substantial wall. Also because the wall friction is usually less at the fresh surface near the bottom of the hole, it may be necessary to drill intermittently permitting sand grains or drilling clays to build up wall friction.

The cone which builds up around an artesian recharge well has been discussed previously. The effect is largely one of pressure, since comparatively small quantities of water go into storage near the well. Under water table conditions a considerable amount of water must be poured into the formation to fill voids within the build-up cone, since in this case we have a free water surface within the permeable formation itself. The comparison is illustrated in Figure 5. Thus, under artesian conditions, the water level rises rapidly and under water table conditions the water rises slowly due to the time required to fill the cone. The difference in time may be as much as three or four days giving time to actually drill the hole before the cone is built up. Also, pumping tests on an artesian formation would enable accurate prediction of discharge well action in this ar-

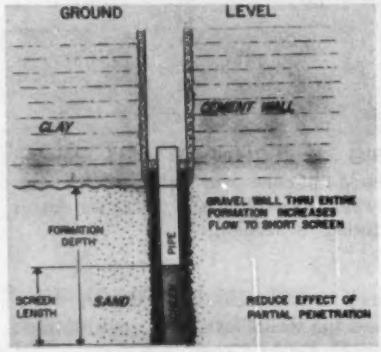


FIG. 6. VARIETY OF well completion procedures is permitted through use of reverse circulation drilling techniques. Possibility of cementing outer casing is important health consideration.

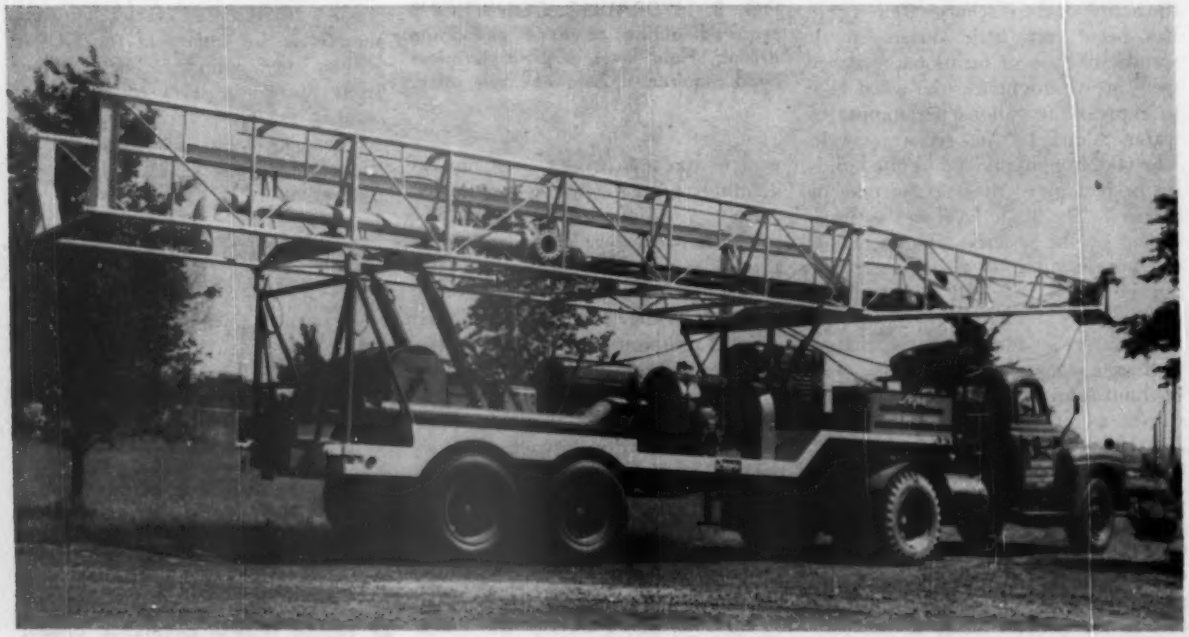


FIG. 7. PORTABLE RIG void in reverse circulation drilling is mounted on tandem axle semi-trailer. Note hydraulic jacks used in elevating tower.

tesian formation, because the actual formation to be used is under test. On the other hand, a test on a discharge well under water table conditions is only partially accurate for predicting how a recharge well will act. This is because the formation under test is only part of the formation which may finally be used in the recharge well.

The above explanation shows some of the problems to be considered when dealing with the static level in a single formation. Often there are a few feet of formation near the surface with a high static level which completely upsets the plans. This formation has to be cased off before the well can be drilled as planned.

Selection of Drilling Method

Although the hydraulic conditions outlined above apply equally well to rotary and reverse circulation drilling a closer examination reveals considerable differences between the two methods. The rotary drill operates at high speeds and produces fine cuttings but the reverse circulation drill operates at very low speed and literally plows the bottom of the hole. In the rotary method, the fine cuttings are floated up outside of the drill rods by a combination of velocity and viscosity. In reverse circulation, the coarse cuttings are pulled by vacuum up inside the drill rods principally by high velocity of clear water.

The selection of which method to use and which method is practical in glacial drift is determined to a large extent by the particle size in the formation to be drilled. This could be roughly explained by stating that the rotary either drills through or between the coarse particles. The reverse circulation method actually pulls coarse material through the rods so that large diameter of drill rods is necessary for large diameter material. Initial experimental work on this type of drilling was done with 7" drill rods as standard equipment with an attempt to use 4" and 12" rods. After several years operation, it is evident that 7" rods will drill about 85% of the wells and 4" rods will handle about 15%. It appears at present that 8" drill rods would be effective in Indiana and Michigan. However, 8" drill rods require a 20" hole to provide sufficient room for water to flow down outside the drill rods. Therefore, it appears that holes 6" to 20" diameter should be drilled by rotary process using 3" or 4" drill rods, and holes over 20" diameter should be handled by the reverse circulation process using 8" drill rods.

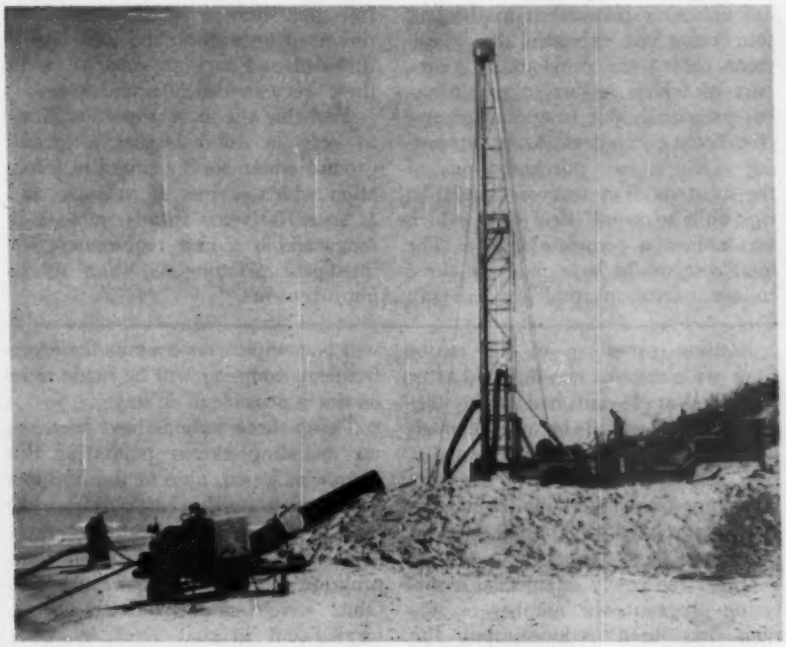


FIG. 8. INSTALLING 38" gravel wall well 60' deep on shore of Lake Michigan. Pit make up water was furnished from lake by pump at lower left.

Reverse Circulation Advantages

One of the principal advantages of reverse circulation drilling is that the hole is completely under control as long as it is kept full of water. The hole can be electrically logged upon completion and an intelligent decision can be made at that time as to whether the yield of the finished well will be sufficiently high to justify completion of the well. Either screen or casing can be easily lowered into the hole or lifted from the hole at will and the well can be constructed in any manner as planned by the engineer. The large diameter hole is available from top to bottom at a lower cost than for such diameters in the past and the water-bearing formation at the bottom of the hole can be cut to a still larger diameter without difficulty. This larger diameter results in some increase in yield, although not in direct proportion, and it permits gravel wall construction of practically any type. A coarse screen and a single gravel wall can be used in a medium formation. A double gravel wall can be used to handle the very fine sand formations with coarse silica sand against the formation and coarse silica gravel against the wide opening screen. Uniform porosity immediately around the screen results in low entrance losses and silica sand is insoluble in chemicals. Also, extension of the gravel wall above the screen substantially reduces the effects of partial penetration. For example, if a screen 20 feet long is set in a formation 50 feet thick, there is 30 feet of formation opposite the casing above the screen. However, if the gravel wall is continued for 30 feet above the screen the effect of a much longer screen is obtained without screen cost. The fact that the hole is completely under control at all times also permits cementing the outer casing which will undoubtedly become more and more important to the Health Departments. These possibilities are illustrated in Figure 6. A 15 pound cement slurry can be pumped from the bottom of the casing up or from the top of the ground down and the casing can be completely encased in cement if desired. The final and probably the most important advantage of reverse circulation drilling is the apparent better yield which is obtained over wells installed by either driving or baling. The only explanation we can offer

is that the hole is kept open by water and is not compacted as it is with driving or forcing screen or casing into the ground by other means. Possibly the fine drilling cuttings of the older methods are forced into the wall of the hole, resulting in lower yield.

Disadvantages And Problems

Reverse circulation equipment, Figure 7, is very heavy and one of the principal problems is to get equipment large enough to handle the work satisfactorily and stay within road limits. The latest mounted rig on a tandem axle semi-trailer weighs approximately 27,000 pounds with a 6" pump. About 20,000 pounds is centered on the rear tandem axle. This exceeds road limits in southern Michigan, so part of the rig is removed in wet weather. A similar truck mounted rig having tandem axles has 25,000 pounds on the rear tandem axles and simply cannot be moved in this area when road limits are imposed. Such limits may be more strict in the future. A complete reverse circulation drilling rig is shown in Figure 8.

There is still some question regarding pump selection, whether to use centrifugal or jet pumps. The jet pump is very tempting, because it provides a clear passage for water. It is an interesting sight to see a 6" jet pump delivering approximately 1400 gallons of water, sand and gravel into a pit. Present pumps are 6" and the next move would be to an 8" pump, though the writer does not know of any pump of this size in service. Larger pumps may require airlift to move the water and the cuttings. Change from a 6" to an 8" pump sounds small, but it will probably double the weight of many of the rig parts. Priming is a problem, whether to use pressure or vacuum, and operation of centrifugal pumps under vacuum can give difficulty, particularly in a portable unit. The drilling bits now being used for reverse circulation work are all home-made since there is no established manufacturer of the type required. There is hardly any agreement on the most effective type of bit and endless shapes and types are seen wherever this type of drilling is done. This is an extremely risky type of drilling in that a complete hole can be lost in 2 seconds. This, however, is not likely to happen if the hole has been carefully planned and if the engineer planning the hole fully understands the conditions which must be met. This type of work requires at least double the planning and supervision done on ordinary drilling work. This is illustrated by the fact that our supervisory group has increased 50% in the last two years, whereas the drilling force has remained constant.

The investment in equipment for recirculating drilling is approximately three times the investment in conventional cable tool equipment. For example, a cable tool rig which could do 80% or 90% of the cable tool drilling for water wells can be purchased fully equipped for approximately $8,000. The smallest complete reverse circulation rig with tools will cost approximately three times that amount. Our investment in the past four years has exceeded the investment during the previous 18 years, part of which is due to expansion, but principally due to adding reverse circulation equipment. As an interesting sidelight, we purchased one of the most modern reverse circulation rigs built to use 4" drill rods, which was almost a complete failure. The total cost would have paid for three college educations and we can say it has provided us a liberal education.

Progress

The search and development of ground water in this area has changed almost completely in the last five years. The following methods which may become well-established within a short time cover the entire field. Electrical Resistivity Surveys, where applicable, provide an initial survey to locate water without drilling more than one hole for calibration. For the balance of the test wells required, rotary testing provides high speed drilling and Electric Logging provides additional accuracy for rotary test wells.

The Aquifer performance test with one or more adjacent pilot wells indicates with reasonable accuracy the quantity of water to expect and guides proper well spacing. Reverse circulation drilling, as it becomes established, will provide more water at less cost from a permanent well.

It is no longer necessary to depend on theoretical arguments over screen construction or well construction. There are now available testing procedures such as step tests which actually measure entrance losses into a well and thereby demonstrate overall performance or well efficiency. A step test with two hours rest period, three hours pumping at half capacity and three hours pumping at full capacity will permit a close estimate of losses into the well due to turbulence. For high capacity wells these become the principal losses.

Probably the most important thing to keep in mind is that a careful ground water survey provides inforation which is just as valuable and as true 100 years from now as it is today and is a first requirement for intelligent planning of water works improvements.

West Virginia Establishes Water Quality Network

A network of water quality monitoring stations has been established by the West Virginia Water Resources Commission. The purpose of this network is to provide a continuous record of water quality at selected points throughout the State. Such information obtained will be published annually and will provide a basis for planned industrial and recreational development and water pollution control.

Routine sampling of all major State-wide streams was initiated after World War II but had to be discontinued in 1955 because enough personnel were not available. At that time, the work consisted of intensive sampling during the summer months and was related to limited or local programs.

Under the newly established monitoring program, the number of stations has been reduced, but the streams will be sampled on a year-around basis. At first, each station will be sampled once a month. More frequent sampling will be made later on if it is possible to do so.

Thirty-three stations have been set up including eleven points in the Kanawha Basin, nine in the Monongahela, five in the Little Kanawha, four in the Potomac, and two each in the Tug Fork and Guyandot. The program will not extend into the Ohio River since work is being carried out in that river by ORSANCO of which West Virginia is a member.

Statutes and Public Service Commissions can provide . . .

Regulation For Better Water Utility Service

by
W. VICTOR WEIR*

EDITOR'S NOTE: Perhaps the last formal presentation by Mr. Weir was this paper delivered before the Eastern Water Company Conference at Atlantic City, N. J., November 12, 1959. Published here with EWCC permission, the remarks illustrate Mr. Weir's deep insight into the workings of privately-owned water utilities. Expressed in his philosophy is the need for wider understanding of current and future utility operating problems by regulatory officials. His parallels to other service organizations are applicable to private and public utilities alike.

■ Despite more than thirty year's contact with "regulations", its meaning is not entirely clear to the writer, nor are answers to the following questions readily apparent:

Is regulation merely to cause utility rates and service to comply with court interpretations of statutes written forty or fifty years ago, or is it to supply controls to take place of those that would automatically exist if the utility industry had free and realistic competition?

Is regulation a legal game, or an accounting game, or is it a procedure by which the utility customers get the service they wish and deserve, with equity for all parties.

Undoubtedly most utilities and commissions feel the latter part of each question is the important part of regulation. So far as utility managements are concerned, they dislike the fact that regulation causes so much time and effort to be spent on rate matters to the detriment of service, and that rate matters are often processed and determined with only a passing regard for their effect upon service.

*At the time of his untimely death, November 19, 1959, Mr. Weir was President and General Manager, St. Louis (Mo.) County Water Company.

Better Service

What is meant by improved service? What is a water utility manager's service goal? Frankly, it is that customers will consider their water utility service to be equal to the best service they obtain, not only from the other utilities, but from the stores and businesses that compete for the customer's dollar.

It has been emphasized that there must be no discrimination between customers, and that regulations are necessary because of water utility monopoly status. Too few people in the industry, however, realize that it is also a service industry, and should live up to the name.

The prime example of a service industry is a clothes cleaning business. It picks up an item, cleans it and delivers it. It pays nothing for the material it processes—it gets paid only for the service performed. Is the water utility business much different? The raw material costs nothing. It is cleaned and delivered. Payment is made for the service rendered and for nothing else. Possibly, a look at the industries generally classified as service industries might teach us some things about customer service.

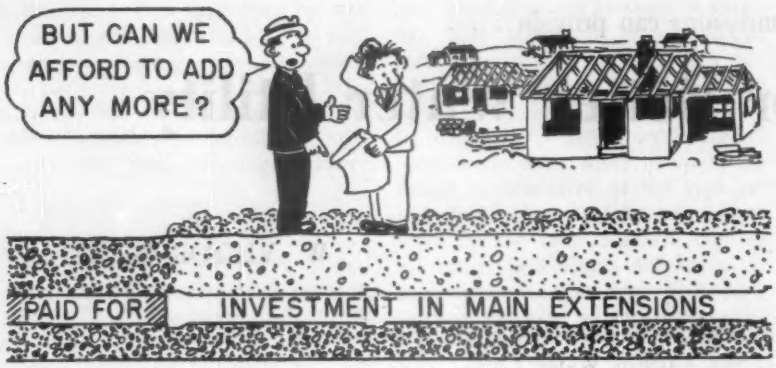
There are water utility practices that should be dropped, some that should be adopted if service is to result in customer good will. Good service can be quickly offset by poor employee-customer relations or by nuisance practices. These things, to a customer, are even more important than the elements that are usually considered "service" under regulation.

Occasional turbid water occurrences incur more ill-will than an inequitable extension rule. A muddy footed meter reader can cause a more permanent reaction than the large bill resulting from the high reading he gets.

Guarantee deposits are one of many standard practices in the water supply industry that could stand reviewing. When a person establishes a charge account for credit purchases, it is a simple thing to do, unless the applicant is known as a credit risk. In the water industry many of us require piddling deposits of $5 to $10 to guarantee water bills, regardless of the customer's actual credit standing in the community. Is this a good business practice? Is this good service?

Other practices that might be reviewed are:

—that of obtaining written con-



tracts from customers—when you order a suit or a piece of furniture do you expect to sign an order for it?

—that of billing bimonthly or quarterly when most businesses render bills on a monthly basis.

—that of allowing rules and regulations to continue unchanged for many years. The rules and regulations are supposed to outline the norms of service, and the utility is supposed to adhere to them. If service has improved over the years the old rules and regulations cannot accurately describe the service to be rendered, or the service actually being rendered.

Planning and Foresight Required

Good service in the water supply industry requires continued planning and foresight, particularly concerning projects that cannot be completed in a short time, or must be started before community development makes them too expensive.

Regulation causes problems in the exercise of foresight. An example might illustrate this. A few years ago in Indiana an impounding reservoir was finished at a cost of approximately 5 million dollars. The management was happy because the utility could get through the next severe drought, whether it occurred the following year or 10 years later, without running short of water. A rate case occurred after the reservoir was finished but before the dry year occurred that would require its use. In establishing the rate base the cost of the reservoir was excluded because the reservoir, although useful, was not "used." There was little recompense in the fact that the order applauded the company foresight in providing this insurance against future trouble, or that the reservoir cost would have been included in the rate base had it been constructed in some other state.

The purchase of real estate for future use poses problems in some states. This particularly applies to obtaining sites for distribution storage tanks. Waiting until an area has built up, then acquiring a site, results in extremely high land costs. But of more importance is that the objections to erecting a tank in a residential area are minimized if the site is purchased and the intended use is publicized before the neighborhood area is populated. Will investments in such "Plant Held for Future Use" be included in the rate base? If not, can interest while being held be credited because of these necessary investments?

If regulation is to affect the use of foresight in preparing for future water demands, its weight should be used to promote, not to discourage, such foresight.

Inflation is a factor that has had a material impact upon utility service, particularly the kinds of service that involve investments. In 1951, when the Public Service Commissions were beginning to acknowledge the fact that inflation was actually being experienced, the Honorable Spencer B. Eddy of the New York Commission had this to say at the Albany meeting of the New York Section of the American Water Works Association:

"As long as the inflationary spiral exists, taxes increase and the costs of doing business rise, the necessity of rate relief can be lessened but not eliminated. The water companies most seriously affected by these factors are those that serve expanding communities requiring additional plant construction . . . . To solve this problem a general investigation of present rules for extensions is being undertaken so that the views of the industry can be obtained. These views will form a basis for discussion, and it is hoped, will provide suggestions for equitable treatment of both the customers and the company." (J.A.W.W.A. Sept. 1951)

Main Extensions

Extensions of mains were then and still are one of the principal service problems in the water industry. The difficulty is that certain types of extension rules result in more rate cases than utility managements wish to get involved with. An example is the extension rule cited by Commissioner Eddy. There were two essential difficulties in 1951 with the old rules promulgated under a General Order: first, seventy-five feet, and more under certain conditions, of free pipe (plus service line in the street, meter, etc.) were to be provided for each new customer; second, the surcharge rate on extensions beyond the free limit was unrealistically low. The general investigation mentioned by Commissioner Eddy was carried out and the views of the industry were stated at length, but carried little weight. The outcome was that the surcharge rate was increased, but the 75 feet of free pipe per new customer was unchanged. The necessity of rate relief occasioned by the addition of new customers was lessened very little.

The application of extension rules may result in complaints to regulatory commissions from prospective customers and real estate developers, but never from old customers even though the extension rules might be unfair to them. Rate cases, caused in large part by so-called "liberal" extension rules, do result in arousing the old customers, but never to the point of causing them to seek a change in extension rules.

Utility managements dislike both complaints and rate cases, but rate cases cause more trouble than the application of extension rules that are fair to the old customers.

How far can an extension rule go without resulting in excessive com-

plaints from real estate developers? The cost of free extension need not exceed 2½ times annual revenue, and might be less. What is the justification for this ratio?

In the last 5 years the St. Louis County Water Company, in Missouri, has added more than 37,000 customers and 430 miles of pipe. The extension contracts in this period have not been counted, but in the first 9 months of 1959 two hundred and five extension contracts were signed for 61 miles of pipe. In these five years, Acct. 241, Advances for Construction, has increased over 2 million dollars, indicating the great activity in new extensions.

The extension contracts are on the basis of the developer putting up the initial cost of 6-inch pipe, unless his subdivision is so extensve that larger pipe is needed to serve it. The refund provision calls for a payment of $50.00 when each premise attached is occupied by a permanent customer. At the end of a year's service an additional refund of 2½ times the year's revenue, less $50.00, is made. No refunds are made for customers attaching after 10 years. The Water Company supplies the meter, but the customer runs the service line all the way to the main.

In this 5-year period the Missouri Commission has received 3 letters concerning water main extensions in St. Louis County: one each in 1955, 1956 and 1959. These letters were from individuals, not developers, and required the Company to write one explanatory letter in each instance. Liberalizing this extension rule could not cut the number of complaints, but would result in a rate base increase that would affect all customers.

Most water utilities have endeavored to change old extension rules that called for 75 to 100 feet of free pipe per customer, or free extensions costing from 5 to 7 times annual revenue. Some commissions have allowed rule changes. Some commissions and some courts have, however, taken positions that maintain antiquated rules and, in the writer's opinion, subsidize new customers by requiring utility investment several times as great per new customer as the investment per old customer.

Some utility managers have admitted dragging their feet when it came to taking on new customers. Instead of willingly seeking customer growth they wished to discourage it because growth meant lowered rates of earnings and less time before the next rate increase applications.

At the aforementioned meeting, Commissioner Eddy also said:

"Companies have not always given adequate or proper service, sometimes because of financial problems, sometimes because the existence of the company was not economically justified and sometimes because of a multitude of other reasons, including the owner's avarice. Such situations move customers being served to demand the acquisition of the plant by either the municipality or a water district to be created for the purpose . . . All too often the bad company providing poor service impels the community to overpay in ridding itself of an inadequate service . . . ." (J.A.W.W.A. Sept. 1951)

Adequate Rates Required

These were strong words because of strong feelings. In effect they said that sometimes stockholders did not invest in facilities for proper service because it was financially advantageous to sell the water systems to cities or districts.

The other side of the coin appears in the 1958 Annual Report of a Water Service Corporation. The report states:

> "It is extremely difficult under the retrospective rate-making policies of the . . . . Commission—which refers to prospecpective developments in its decisions but bases its determinations largely on the utility's past costs—to protect our shareholders fully against the erosive effect of inflation on earnings and rate of return . . . . We shall continue to endeavor to convince the Commission that a niggardly rate-making policy which disadvantages the shareholders is not therefore beneficial to our customers or service levels. De mands for additional and improved service can only be supplied by facilities financed with capital on which the allowed rate of return must be earned—not intermittently through hypothetical adjustments but consistently, regularly and in reality."

In the same Annual Report is the statement that in making sales of water works' properties since 1951, in condemnation cases or sales in lieu thereof, "the Corporation and subsidiaries received payments aggregating $35,255,000 for properties with a rate base carrying value of $16,433,000 as recorded on the books on the several dates of disposition in conformity with Public Service Commission requirements."

Other instances might be cited where water system owners, who were initially interested in operating their properties, have sold them at prices that were 75% to 100% higher than net original cost and approached reproduction cost depreciated. Some of these sales were on the basis of condemnation, but many were at arms-length prices with both sides believing the transactions had been financially profitable.

If it is ever financially desirable for the owners of a water utility to sell a property, then a definite conclusion can be reached concerning that situation: the return that the owners expect under regulation is less than the return expected to result if the market value of the property is invested in some other enterprise having equal risk. When a utility property is for sale, it is evident that the owners not only believe they are being underpaid with inadequate return, but are willing to back up that belief with action. Such stockholders were exercising business judgment, not being avaricious.

Assuming that the water utility business is a proper place for private enterprise, the normal situation should be that stockholders would be just as willing to keep their investment in a water company, and leave earnings and provide new money when needed to extend and improve service, as to take their money out and put it into some other business. When there is a desire to sell at a price below reproduction cost depreciated, it is evident that stockholders are dissatisfied with the regulated return and believe they can get a better return with equal risk elsewhere.

When water works managers find themselves between unserved or poorly served customers on one hand and dissatisfied stockholders on the other, they are in a very difficult position. Forgetting about extending or improving service, it takes new money just to maintain service, and that

new money must come from the stockholders. If stockholders are happy about earnings, they will be glad to make additional investments; if dissatisfied, they will feel that they are being asked to throw good money after bad. Water works managers have as much trouble in providing good service with disgruntled stockholders as they would have with disgruntled employees.

Regulatory climate definitely affects quality of service. The latitude that most Commissions have is wide enough to evoke poor, mediocre or excellent service without burdening customers with excessive charges.

Water utility managers, as a group, wish to provide the very best of utility service, not just the quality called for in statutes and Public Service Commission general orders, which is minimum service. Utility managers realize that there must be a better understanding of the problems involved and mutual education of all parties involved: themselves, their employees, their stockholders, the customers and the regulatory commissions, and will welcome all the constructive criticism and cooperation they can get that will result in improved water utility service.

Wyoming Official Comments on Water Control

In an address before the Wyoming Chapter of the Soil Conservation Society of America, Wyoming State Representative Marlin T. Kurtz asserted that both surface and underground water should be governed by interstate compacts.

"We must step up efficiency in the use and distribution of water between states." Noting that Wyoming dams are storing for use in Nebraska, Kurtz declared that Nebraska has a "large untapped supply of underground water which isn't being utilized. We don't have extensive underground water in Wyoming."

The Wyoming Congressman continued his discussion remarking that "Some system must be devised wherein states with underground supplies of water utilize that water—leaving the surface water for those states needing it."

Georgia Tells Story of Water

The story of water supply from the stream to the faucet has been told in a 15-page illustrated booklet issued by the Georgia Department of Public Health.

Entitled "Science of Water Supply in Georgia," the booklet was written by W. H. Weir, director of the Department's Water Quality Service. Copies are available to students, teachers, and all others interested in a clear and simple description of Georgia's water supply.

Sections of the booklet include "Water Conditions in Nature," which points out that where water is abundant there is always plant and animal life, and "Contamination in Natural Waters," which describes the effects of bacteria and other biological materials, as well as soil, which affect the quality of water. Other sections describes water supplies and water problems in Georgia cities, water purification and treatment, and water responsibilities of governments, industries and citizens.

The booklet also points out the assistance cities and towns receive from the Georgia Department of Public Health, which must approve sources of water and methods of purification. Samples of water are sent from all public water supplies each month to the laboratory of the Health Department to be examined for bacteria.

Requests for copies of the bulletin should be addressed to the Water Quality Service, Georgia Department of Public Health, Atlanta.

Hawaii Studies Ground Water Resources

A Statewide exploratory well drilling program to obtain information on ground water resources was launched by the Hawaii State Water Authority. The agency recently advertised for bids to lease well drilling equipment for this project.

Robert T. Chuck, acting Manager-Chief Engineer, said that with statehood and "subsequent talk of new developments, the first question is: 'Where will the water come from?' We want to stay ahead of the development with ground water information."

The authority is to conduct the program assisted by local geologists, various State Departments, county water boards and departments, and private industry. The first Hawaiian State legislature appropriated $90,000 for the initial stage of the project. Wells drilled by the Authority will be under State jurisdiction.

Dobbins Receives USPHS Grant for NYU

The mechanism of gas absorption by liquids, an important factor in water pollution control, will be studied by Dr. William E. Dobbins, Professor of Sanitary Engineering at New York University's College of Engineering, under a $12,769 grant from United States Health Service.

He is seeking a theoretical explanation of the way gas is transferred from the atmosphere to a large body of water.

When organic matter decomposes in water, the oxygen it uses must be replenished by dissolution from the atmosphere. The rate of this oxygen transfer is critical because a stream becomes objectionable when its oxygen content falls below a certain level.

Dr. Dobbins' study of the gas absorption mechanism will aid in determining the amount of treatment required by organic wastes before they can be dumped without causing excessive water pollution.

Sewage and Water Works Construction—1959

The United States Public Health Service has released its compilation of data concerning and entitled, "Sewage and Water Works Construction—1959".

Section I contains a general presentation of 1959 contract awards and an explanations of the method of data collection.

Section II presents that basic data covering the contract awards and is divided into the following chapters: Sewage Treatment Works Construction; Collecting Sewer Construction; Water Works Construction; and Combination Construction.

The total dollar value of construction for sewer treatment was $349.2 million; for collecting sewers, $335.8 million; for water works, $503.9 million; total for the sewage and water works field, $1,188.9 million.

Copies of the publication may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C., at 20c each.

Partially Oriented on . . . . .

Cryptic Christmas Cards

I see that our major civil engineering institution has again produced a Christmas card this year "for the use of members". The card carries "a reproduction of a painting of a locomotive designed by Richard Trevethick to haul coal on a tramway at Penydaren, South Wales, in 1804."

Possibly I am out of date in this Christmas card business—1804 years out of date to be engineeringly precise. Possibly I have got my institutions confused also—I thought a locomotive was a mechanical device. But anything jolly or heartwarming on a Christmas card goes with me all right. As long as there is a little bit of snow around the locomotive, or Father Christmas popping out of the chimney, or a robin or two hopping around I shall be happy. That kind of thing makes me remember it *is* Christmas.

Locomotives, too, I like; especially the old ones. I always put pennies into those little models they still have around at railway stations and get great enjoyment from seeing the wheels go round. It will be a sad day for me when Christmas cards turn to reproducing "a painting of the first diesel-electric train to run on the London to Crewe route."

Christmas is a nice time for reminiscing, and it often brings some surprises with it. I got a card one year printed by the Marriage Guidance Council. It had a picture of a dove with an olive branch in its mouth. I thought that was a very nice message—particularly as it was sent to me by two friends who had just managed to get themselves married together after tiresome, though unrelated, divorce proceedings.

The human race (and the engineering fraternity) are, of course, a continuously surprising quantity. I suppose the engineering fraternity is just a "sample population" from the "entire population" and the surprises you get from one will repeat the surprises you are likely to get from the other. For instance, now that I think I have got the hang of this Christmas card business, it is likely that some of my colleagues will get considerable surprises from me this year with my specially chosen Christmas cards. I want them all to have a special "message" this year, like the ones I have quoted above (except that the message of Trevethick's locomotive escapes me for the moment).

There is a friend of mine, who is very keen on music and usually sends me Christmas cards showing funny men playing funny musical instruments in a funny way. I think I shall send him this year a card with a picture of a concrete mixer on it.

I was thinking of the boss for a moment then, and then I thought I had better not. You have got to be very careful with bosses. A little too much levity and things can go astray, even at Christmas. I think I will play safe and just send him a picture of a glass of cool water. Not too sentimental you see; no implied criticism in that either.

Now we have my friend, the Contractor. I shall have to think up something special for him. No, I don't think I will send him the dove with the olive branch—might indicate a sign of weakness. In any case it isn't my turn to climb down . . . . . sorry, I was forgetting it was Christmas. I know! I'll send him a picture of a waterworks plant—that should cheer him up.

Who's next on the list? Ah—the soils mechanics boys—mustn't let them forget me. How about that photograph of S. the day he tried the shear apparatus on those samples we mixed up with olive oil? Hm. I do keep forgetting it *is* Christmas. I wonder why olives keep coming into my mind?

Now there is poor old M. to think of—chained to the drawing board after five years of freedom roaming around job sites. I guess he would appreciate this picture of a D.8 bogged down while trying to rescue a D.4 which had bogged down trying to pull out the dumptruck which had been sent to rescue the site van which had got stuck in the mud. That should bring the flavour of the open air life back to him.

How about this photograph of the leaning water tower? Quite unique that photograph is—not many of them get to such an angle and still stand up. There should be someone I could send that to. Ah—I know. But might it be a pity to waste a good picture like that—especially when you know a chap who has actually designed several water towers? I wonder what results he is getting with *his* designs.

A funny thing about choosing Christmas cards this way is that it seems simpler than the old fashioned way. You take a picture and it isn't a moment before you know who you ought to send it to. Here's one of a Deacon waste meter—just the thing for the water engineers I know ("waste not, want not"). Here is one of a grader at work—just the thing for D., he is always moaning about grades in the civil service. This scarifier will do for K. who still doesn't comb his hair; this 8-ton roller will do for N. who is getting so fat . . . . .

Tut, tut . . . . . what *am* I thinking of? I think I'd better get back to robins and snow and candlelight —or else send this picture of a bashed-in tin helmet to myself. I'm getting to be a nut case.

Needs for more and better training are met by the . . .

Missouri Water and Sewage Technical School

by ELSIE BISSETT, Lab. Tech.
Sewage Treatment Plants
Joplin, Missouri

EDITOR'S NOTE: The failure of voluntary certification indicates a need for more of the specific training activities reported here. Considerable authoritative agreement exists on the need for required certification which will require raising the academic level of water and sewage treatment plant operators. Schools of the type described in this paper are an excellent means of providing the necessary training.

■ LINCOLN'S STATEMENT regarding the function of government can well be rephrased to fit the function of a school: The function of a school is to do for the people what needs to be done that they cannot do at all for themselves, or do so well.

In 1958, bearing these needs in mind, Lloyd Caughran, Supt. of the Water Filtration Plant, Neosho, Missouri, presented the training school idea to the Missouri Water and Sewerage Conference. The school proposed was to be separate from any other institution.

The Needs

For Economy

"What we have to do will have to be done with just what we have at hand." This thought has dominated the thinking of many mayors, councilmen and city managers. Nearly every likely solution to his problem, unless already at hand or specifically stated and allowed for in the budget, was prohibited.

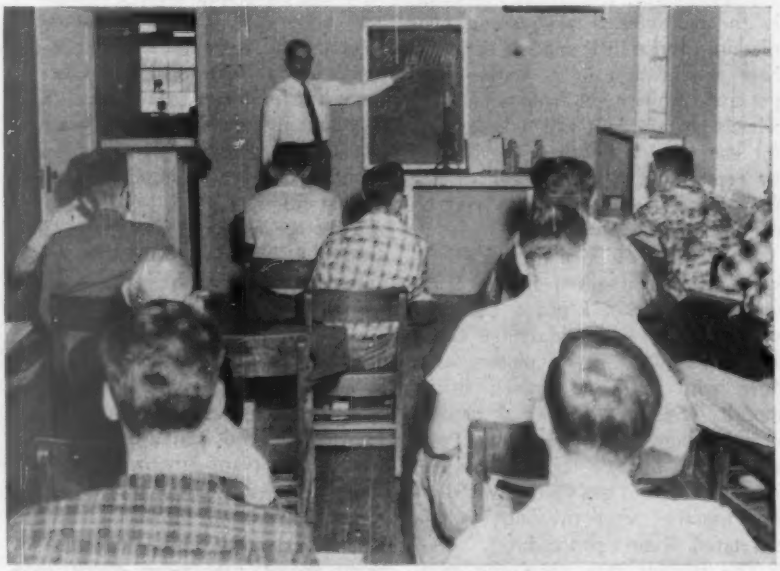
The cheapest is not always the most economical when the whole problem is viewed from the angle of economy. In the opinion of William G. Riddle, Consulting Engineer, Kansas City, "The only instruction some operators have had is from service men called out to repair breakdowns caused by improper handling."

Compare the cost of preventable breakdown against the cost of instruction and re-evaluate the economy angle.

To Get the Job Started

"We have a new three-million dollar plant and we're proud of it!" one city boasted, but the Water Pollution Control Board continued to receive reports of bad stream pollution.

Jess Barlow, itinerant instructor for the Missouri State Water Pollution Control relates the incident about the unidentified sewage treatment plant this way: "I received a report that the stream was in pretty bad condition and this was a good two or three months after they had constructed a new sewage treatment plant, so I stopped by to see what was



SCHOOL DIRECTOR, Lloyd Caughran conducts bacteriology class. He was awarded the Missouri Water and Sewerage Conference Award of Merit for his efforts in making the school a reality.

wrong. I asked the operator how things were going. "Things are going fine, Jess. Just fine," he said. I thought I would take a look anyway. I checked the primary sedimentation basins first and there wasn't a drop of sewage in them. They were just as clean as the day they were made. He was still by-passing to the creek."

Professional Pride

"Why should we design a five-million dollar plant and turn it over to Joe Blow to operate? He can make us and the contractor look bad." These are the sentiments expressed by a number of consulting engineers and contractors and their growing determination to see their "baby" receive the kind of treatment it deserves.

For Safety

The operator needs to be protected from himself. He needs instruction in what to do, certainly, but almost as acute is the need to know what not to do. A typical preventable accident involved an airman who filled a soiled paper cup, rather than the usual plastic cup, with calcium hypochlorite preparatory to adding the solution to the automatic chlorinator. The paper cup burst into flames. In the resulting fire and explosion the flaming material liberated toxic fumes, one man inhaled chlorine gas and two men were burned.

Directed Development

Joe Blow is not always the incompetent, even when not formally trained, as your own water supply and sewage treatment service will tell you. The responsibility has been a heavy one and he has been delivering a product and a service which has received public acceptance if not public acclaim. Frequently the demands of his duties were too pressing to allow time off for attending University short-courses. He did the best he could to instruct himself by text book and trade publication.

Joe has done well in most instances by trial and error, but how much more effective the results might have been, with directed instruction aimed at eliminating most commonly recurring errors.

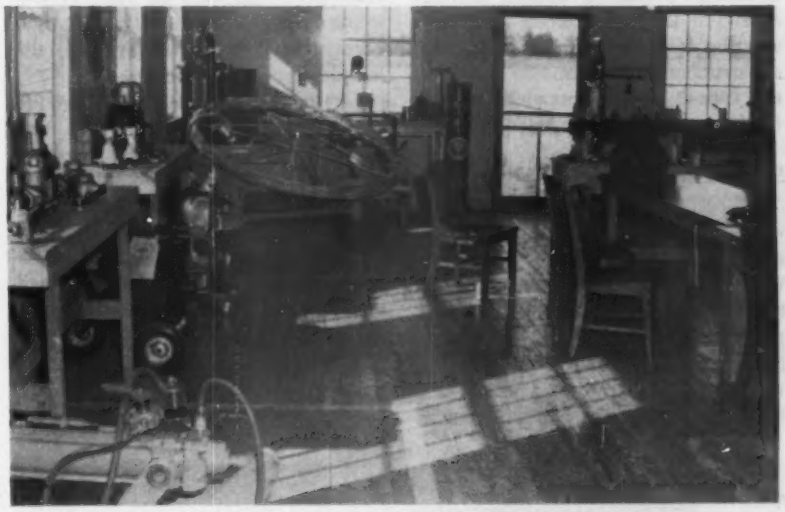
Trial and error type of experience are recognized and valued in the field. The lowest license examination in Missouri is offered to applicants having two years experience or more in the work for which they apply for examination. However contrary to good reasoning this trial and error theory seems, the facts are that in a field in which formal instruction is often non-existent, the person who can do his job well enough to retain his position for two years is then entitled to continue to perform with public approval.

Many of the medical men now in the field of public health present this argument: "Imagine the deplorable state of surgery if every high school boy desiring to become a doctor were handed a scalpel and told to practice surgery for two years and if his patients didn't complain too much he would receive a license to practice." An examination of medical history reveals that medicine developed very nearly in this manner. But, in the fields of water and sewage, trial and error development is not essential to industry maturity. If enough techniques now known were practiced by the employee many of his problems would be solved.

Medical men and engineers squabble over which profession should dominate and direct water and sewage operations. Mayors, city managers, and councilmen haggle with the public over budgets. Meanwhile, water and sewage treatment plant employees struggle through trials and errors with all the crude, painful and wasteful aspects.

To Protect Public Health

Ethical, mature, responsible, are words the water and sewage men use to describe qualities they want to find in themselves. That these qualities are already prominent in many employed in the field of water and sewage is evidenced by the fears they express. Casey Forbes, Supt. of Utilities at Springdale, Arkansas stresses the need of every citizen for protection against untrustworthy personnel: "We know that he can be the cause of an epidemic that every medical doctor in the city cannot handle."



MECHANICAL LABORATORY is a unique feature of the school. Equipment is donated or loaned by suppliers or manufacturers.

The same superintendents and operators voicing these fears are creating practical ways and means to eliminate reasons for fear and to prevent problems. The best way of all is to provide instruction.

The License Certification Committee has recognized, and taken steps to eliminate, morally irresponsible people from the industry. This is done requiring that at least two character certifications accompany each application for license examination. But intention is not always prevention unless the operator is informed through proper training.

Training Better Than Explaining

Narrow indeed are the margins of public safety when a glass of water drawn from the tap has an inch high head of foam and the consumer jokes about it. Sometimes the immediate answer to the water problem has the

appearance of a grim joke. "Me understand," the aborigine paraphrases white man logic, "When dog hungry, chop off part of dog tail and give dog to eat."

Would not the money the city spent employing extra telephone receptionists to explain to the public that the water just drawn to drink is safe and harmless even if it does contain a dozen or so tiny swimming worms, be better spent to train its operators? True, all of the problems are not the fault of the operator and perfectly trained operators will not eliminate all of the problems. Much is due to lack of sewage treatment facilities at all, or an urgent need to expand existing facilities. Concurrent with construction and expansion should be the training of personnel to operate the facilities.

Speed Essential

The License Certification Committee is convinced that voluntary licensing programs cannot keep pace with the critical need for competently trained water and sewage treatment plant operators. It has prepared a bill requiring mandatory licensing of water works operators. The bill will be presented for passage at the next Missouri General Legislative Assembly which will convene in January, 1961.

The facts as to how and why voluntary programs are behind schedule are explainable and not always reasons for apology. Dr. Warren Kramer, Chief, Water Supply, Missouri Division of Health, states the explanation in these words: "The program for the voluntary licensing of water and sewage plant personnel has lagged behind what we had anticipated for a number of reasons. The major reason being the inability of the University of Missouri Short-Course to train personnel with the rapidity that expanding existing facilities and the construction of new facilities demand."

During the past four years more than 60 new sewage treatment facilities have been constructed in Missouri. Few water or sewage plant operators care to make application for examination without the background afforded by the formal training of a short-course. They prefer to await their turn for admission to the university short-course. While numerically the quota of trained operators rise, the percentage quota is falling, a fact involving both pride and concern. This dualism of emotion and of purpose appears to be an integral part of the period in time in which we live. We cannot do justice unless we deliver both a kick and a kiss simultaneously.

Need for New Techniques

In the same way that Missouri's voluntary licensing program has lagged behind, conventional water and sewage treatment techniques and analyses are becoming inadequate. The Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio warns of agricultural pollution of drinking water supplies. This pollution is mineral in nature. The technical age has inaugurated needs to detect and control industrial, as well as agricultural, pollution of water supplies and of sewage received at the plant for treatment.

How close are we to probable distribution of completely sanitary yet thoroughly poisonous water for consumption, if only conventional water treatment techniques are used? The danger to the sewage collection system and to the treatment installation lies in premature distruction of both. The corrosive nature of some waste and mixing of certain industrial waste with domestic waste may render the plant ineffective in treating any of the incoming waste. The plant operator must be able to distinguish the treatable from the harmful, to identify the nature of the waste whether animal, vegetable, or mineral contaminants. Training in the necessary techniques will bring the plant operator up-to-date. It will equip him to deal with a future in which atomic waste problems may be commonplace.

International in Scope

Inquiries have been received by Lloyd Caughran, Director of the Missouri Water and Sewage Technical School from sources scattered throughout the United States, from the Army, Navy and countries in South America. Students have been enrolled from Arkansas, Oklahoma, Kansas, Nebraska and the Richards-Gebaur Air Force base. Inquiries and applications from students in other states having training and licensing programs indicate that these states are experiencing problems similar to those in Missouri.

Aside from the fact that only one or two short-courses can be held each year, the most frequently mentioned complaint is that the university or

STUDENTS AT WORK in chemistry laboratory during water works school. Missouri, Arkansas and Oklahoma are represented in the group.

college short-course does not train the student in using mechanical equipment which he will operate. Winter weather often cancels student schedules and training may be deferred two or three years, depending on the backlog of applicants.

What The School Is

Location

In August 1959, Dr. Warren Kramer, Secretary of the Missouri Water and Sewerage Conference and Lloyd Caughran, signed a five-year lease with the Army for a vacant crafts building at inactivated Fort Crowder, near Neosho, Missouri.

Unique Features

The Missouri Water and Sewage Technical School is unique for being the only school devoted exclusively to the instruction of people employed in the fields of water and sewage treatment. Where other institutions have allotted only one or two weeks of each year for this training, this school operates full time. Classes meet every day for a one-week basic course, one day a week for six weeks to cover the same basic course, or one evening a week for ten weeks. This flexible schedule allows the student to attend without disrupting work schedules if he has no one to replace him on the job. The school is also unique in having a mechanical laboratory.

Type of Instruction

The training schedule is planned to develop the student on three levels of awareness as follows:

1. Through lecture and text book assignment
2. By actual demonstration
3. By practice assignments using the type of equipment in service at water and sewage treatment plants.

The lecture room is provided with a lecture and blackboard for the instructor and chair-desks for student use.

The mechanical laboratory, a separate room, is devoted to the display of mock lay-outs of water distribution systems, sewers, and sewage collection systems. Full size cut-away models of meters, pumps, hydrants and valves are included in the exhibit. Chlorinators and similar apparatus, pieces of equipment the student will find in actual use in the treatment of water and sewage are located there. They are taken apart and reassembled by students under direction of the instructor. Sewer-rodding equipment and water and sewer tapping equipment are on hand for the student to haul out and operate to gain proficiency. This is first done under the direction of the instructor and later solo, or in cooperation with other students to perfect technique. Water meters and sewage gas meters are available for practice setting and servicing. Many other pieces of mechanical equipment, installing devices and maintenance tools are on hand to acquaint the student with their intended purpose and effective method of operation.

The chemical and bacteriological laboratory contains shelves of chemicals and glassware. Flasks, beakers, graduated cylinders, petri dishes, culture tubes and pipettes are included. The work tables contain burettes, color comparators, turbidimeters, and other associated apparatus for making laboratory analyses.

Sample Curriculum

The basic sewage course follows as an example of what is accomplished in a week-long course:

Monday	
9:00-9:45 a.m.	The Role of the Sewage Treatment Plant Operator in the Field of Public Health
9:45-10:30	Sewage and Its Relation to Public Health
10:30-11:15	Bacteria and Micro-Organisms in Sewage Treatment
11:15-12:00	Chemical and Biological Composition of Sewage
1:00-5:00 p.m.	Laboratory Techniques
Tuesday	
9:00-9:45 a.m.	Primary Sedimentation
9:45-10:30	Imhoff Tank
10:30-11:15	Sludge Digestion
11:15-12:00	Vacuum Filtration
1:00-5:00 p.m.	Laboratory Analysis
Wednesday	
9:00-10:00 a.m.	Standard Rate and High Rate Trickling Filters
10:00-11:00	Clay Pipe in Sewage Systems
11:00-12:00	New Clay Pipe Tapping and Equipment
1:00-5:00 p.m.	Laboratory Analysis
Thursday	
9:00-9:45 a.m.	Sewage Lagoons
9:45-10:30	Pumps and Pumping
10:30-11:15	Activated Sludge Process
11:15-12:00	Operation of Heat Exchangers
1:00-5:00 p.m.	Laboratory Analysis
Friday	
9:00-11:00 a.m	Special Problems of Sewage Systems
11:00-12:00	Safety
1:00-4:00 p.m.	Review
4:00 until completion	License Examination, if desired.

Governed by School Board

The school board is composed of three members: Kent Roberts, Professor of Sanitary Engineering, Missouri School of Mines, Rolla, Missouri, Chairman; Sidney Smith, Superintendent of Sewage Treatment Plants, Joplin, Missouri, and Dr. Warren Kramer, Chief, Water Supply, Missouri State Division of Health. The board formulates the school policies, provides the faculty and plans curricula.

Endowment Committee

The school is not self-supporting. The student pays a $10 registration fee. Included is tuition, text book and sundry charge, no other fee being required of him. Endowment accounts for the bulk of the budget. The endowment committee is responsible for providing the financial means and handling all budget problems.

If the engineering profession appeared adamant in describing the need for operator training, it has been just as unyielding in providing the means for that training. It has been from these critics that the endowment committee has been chosen. Charles Brooks, of Haskins, Riddle and Sharp, Kansas City, Missouri is Chairman of the endowment committee. He is assisted by Robert Hedges, Rockwell Manufacturing Company, and Norman Collins, U. S. Dickey Clay Manufacturing Company. Letters to this committee may be addressed to P. O. Box 1301—Kansas City, Mo.

The Missouri Water & Sewerage Conference, parent organization of the school has been registered with the Department of Internal Revenue and endowments and donations are legitimate income tax deductions.

Registration Not Limited to Missouri

Registration of students for training in the school will not be limited to residents of the State of Missouri. The $10 registration fee applies to in-state and out-of-state students. Limits on registration have been how

OBJECTIVE OF ATTENDANCE is to obtain a voluntary license. Student is shown appearing before the examining board.

many and not who. Students are accepted in the order their applications are received. Classes include a maximum of 25 students to permit the instructor to give each student the individual attention he needs.

Lawrence E. Martin, Chairman of the Missouri Water and Sewage Conference and office manager of the Missouri Water Company, Independence declared: "We particularly want mayors and city managers to know that this training is available."

Instructors

The instructor pool is composed of engineers, Missouri State Division of Health Personnel, Missouri Water Pollution Control Personnel, sales representatives, equipment manufacturer's service men, water works and sewage works superintendents. None of the instructors receive financial remuneration. No sales representative, equipment manufacturer's service man, nor consulting engineer may use his position as instructor to promote the product or service of his company. Entertainment, advertising, sales promotion and demonstrations are prohibited at the school by agreement with the instructors and the company with which he is associated.

Supplies

Equipment and supplies used at the school are donations or on loan from suppliers or manufacturers. Supplies are not provided for the purpose of promoting any particular product and they are utilized competitively with other products donated or loaned for the purpose.

Installations

Instruction in the operation and maintenance of equipment too large for school demonstration has been arranged with a treatment plant located within practicable driving distance of the school. An example of such a course was a three day vacuum filtration course held at the sewage treatment plants in Joplin on April 19-21, 1960. The same training techniques are used at the plant as are used at the school: lecture, demonstration and practice operation. The plant continues operating as usual both from the stand point of necessity and for instructing the student by observation of all the integrated phases of plant operation.

The Joplin Water Works Company has made available its new four unit Aldrich Perifilter Purification Plant for student training. "Aldrich units are often referred to as push-button facilities because they employ so many automatic devices, but flesh and blood workers are still important to operation," said John O. Newton, Manager. He has invited students to visit the modern laboratory to observe techniques in testing water purity, clarity, and taste.

The activated sludge plant at Springfield, Missouri is within driving distance of the school. This plant treats the combined waste of its domestic and industrial population. Allan Mayfield, Sanitary Engineer with the City of Springfield is a popular instructor at the school.

Educational Background

Educational background has been widely varied among the students and no attempt has been made to segregate the literati from the literate. Some students come with a third or fourth grade education and are just as responsive to the instruction as are students with degrees in engineering. *Mayor* is a popular title for students who often come to satisfy their curiosity as to whether this unorthodox group is accomplishing anything worthwhile.

Student Attitudes

An average student expresses his feeling at the end of the course with words similar to this: "I've been in this business a good many years and I never knew there was so much to learn about it."

George F. Ferrel, Water Works Superintendent of Liberty made this comment: "I wanted first-hand knowledge of the school's operation and made arrangements to attend a full water works training session. From the first call to order, enthusiasm ran high and was practically unbounded by the end of the week. I have, as yet, to talk with any visitor to the school who did not, after seeing the school and learning of the operation, depart without acquiring this same enthusiasm."

Applications and Information

Applications for admission to the school are directed to Lloyd Caughran, Director, Missouri Water and Sewage Technical School, P. O. Box 348, Neosho, Missouri. A brochure of detailed information about the school, classes and answers to most frequent inquiries is being prepared for distribution.

For the Future

Plans for the immediate future are to give 20 alternate courses of instruction in basic water and sewage techniques. As soon as the backlog of waiting applicants for basic instruction is cleared away, the training schedule will range upward and instruct in the next highest level, culminating in "C" license examinations.

Summary

The need for the school and its intent can be summarized in this statement by Lloyd Caughran: "These courses are going to raise the prestige of the operators and their confidence in themselves. But, most important, it will assure the public of a potable water supply and proper handling of their sewage."

The Missouri Water and Sewage Technical School is an institution created and supported by the people actively and intimately engaged in water and sewage treatment problems, to do for themselves what they alone cannot do at all, or do so well.

RESEARCH PROGRESS REPORT

Radioactive tracer serves important function in determining the . . .

Distribution of Carbohydrate Metabolism In Sewage Sand Filters

By GEORGE B. MORGAN and F. W. GILCREAS, Assistant Research Professor and Professor of Sanitary Science, respectively, Earle B. Phelps Laboratory for Sanitary Engineering Research, Department of Civil Engineering, University of Florida, Gainesville, Florida.

RESUME: Chemical and radio-chemical methods were successfully used to study the distribution of carbohydrate metabolism in pilot plant and laboratory scale sand filters. Carbon-14 tagged glucose was selected as the tracer for the studies. Apparent need for ventilation in lower sand levels is shown by loss of BOD removal ability and absence of nitrogen fixation under anaerobic conditions.

■ FOR THE PAST 60 years the intermittent sand filter has provided an effective method for treating the wastes of small towns, industrial establishments, and institutions. This method of treatment consists of passing settled sewage through a bed of sand and collecting the effluent by an underdrain system. If the sand bed is operated properly a clear, sparkling and nitrified effluent is obtained. The method of construction and operation of a sewage sand filter is relatively simple. The mechanism of BOD removal is based on a series of physical and biochemical reactions. As the name implies the first function of the sand is the filtration of sewage to remove suspended solids not eliminated by primary sedimentation. Another function of the sewage sand filter is the biological digestion or absorption and utilization of the dissolved organic matter.

The distribution of bacteria in sand filters appears to follow a pattern. In the upper few inches *Zooglea* and *Flavobacterium* are the predominant organisms.[1] These organisms decompose complex protein and carbohydrate molecules. Part of these compounds are utilized for protoplasm synthesis and stored food. The waste products consist of less complex molecules which are available to the *Alcaligenes* group, the predominant group in the middle portion of the sand filter.[1] Nitrification takes place in the lower portion of the filter. Nitrobacter has simple nutritional requirements and it has been reported that their growth is inhibited by the presence of much organic material.[2] Many workers have reported that most of the organic removal is accomplished in the upper 8 in. of the filter.[3] These reports were based on the removal of BOD and suspended solids.

The purpose of this investigation was to determine the distribution of carbohydrate metabolism in intermittent sand filters by utilizing chemical and radio-chemical methods.

Apparatus

Sand Filters: Three types of sand filters were used. These are as follows:

1. Pilot plant filters, 36 in. diameter and 36 in. depth. The sand in these units had an effective size of 0.35 mm and a uniformity coefficient of 1.53.

2. Laboratory scale filters, 12 in. diameter and 12 in. depth. The sand had an effective size of 0.31 mm and a uniformity coefficient of 2.40.

The hydraulic loading on these filters was 200,000 gallons per acre per day and the BOD loading was

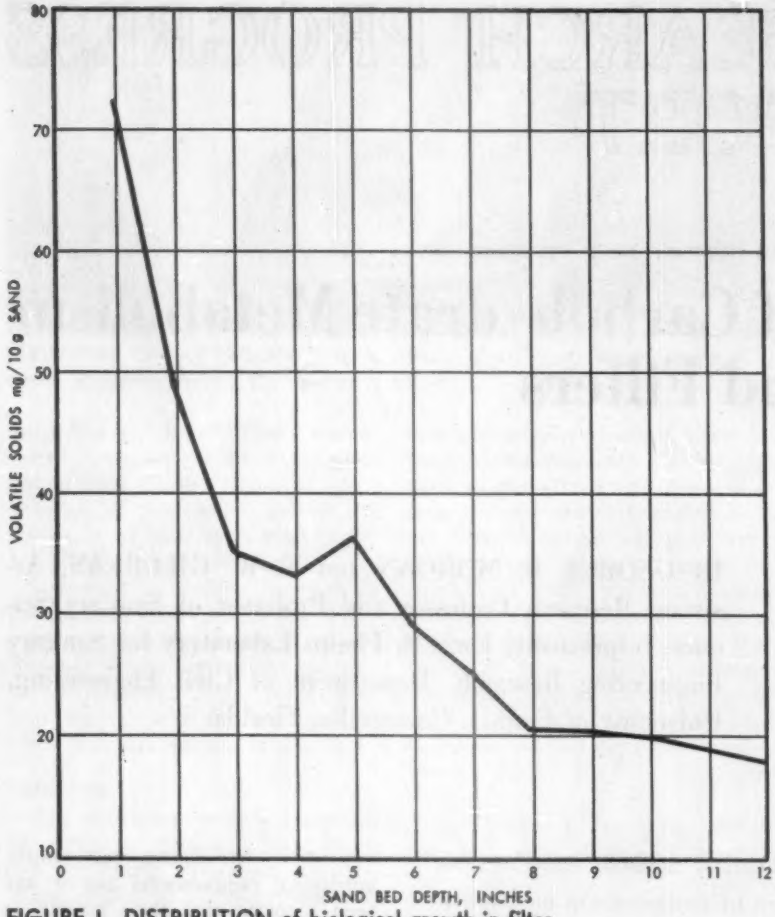


FIGURE 1. DISTRIBUTION of biological growth in filter.

325 lbs. per acre per day. All sand beds were biologically mature at the time of the study.

Counting Apparatus: A Nuclear-Chicago Model D-47 internal proportional flow counter in series with a 192-A ultrascaler, C110-B automatic sample changer, D-47 preamplifier and a C111-B printing timer was assembled for radioactive measurements.

Special Reagents

Glucose-C^{14} uniformly labeled was the carbohydrate selected for this investigation.

Methods and Procedures

Distribution of Biological Growth

Accumulation of volatile solids in the sand filter were considered to be an index of biological growth. To ascertain these values the pilot plant sand filter was cored with a two in. tube. The core was subdivided into 1 in. sections. The weight and volume of the sand section and organic material was obtained by measuring the displacement of water by the sand, then drying and weighing the sand. The dry sample was ignited at 600°C for 30 minutes, cooled and reweighed. The biological growth was calculated as mg of volatile solids per 10 grams of sand. Results are presented in Figure 1.

Buffer Capacity

The buffer capacity per unit volume of volatile solids was used to measure the organic acids produced by the decomposition of organic compounds. The buffer capacity is defined as the milliequivalents of hydrogen ions needed to raise the acidity of an aqueous suspension containing 1 mg of volatile solids to pH 3. Core samples were used and volatile solids were determined as in the previous paragraph. Results are presented in Figure 2.

BOD Removal

The 12 inch laboratory filter was employed to study BOD removal with respect to depth. An artificial sewage containing no suspended solids was the nutrient for this study and consisted of 0.075 g each of glucose, peptone and powdered milk

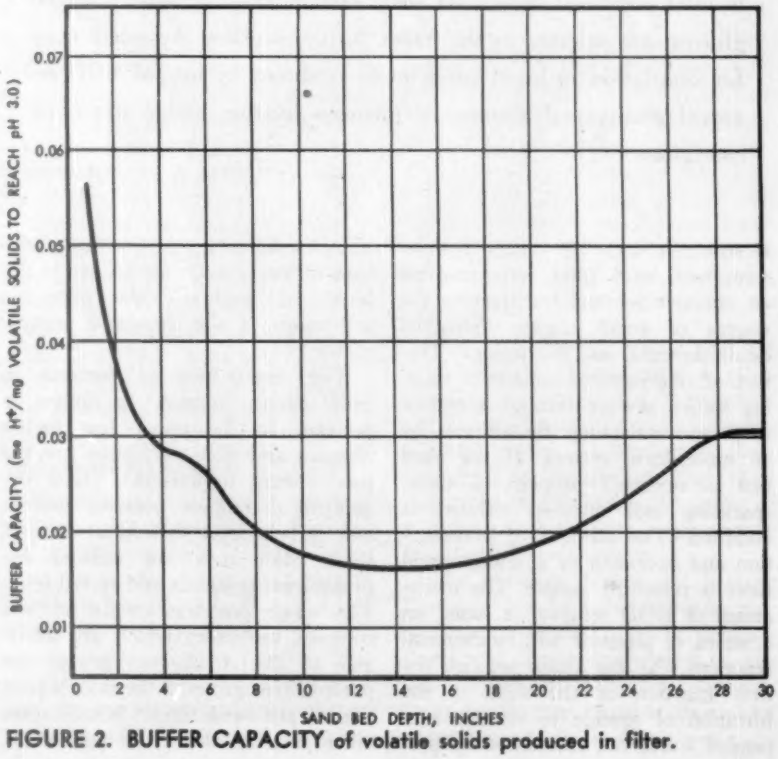


FIGURE 2. BUFFER CAPACITY of volatile solids produced in filter.

dissolved in 1200 ml of BOD dilution water. This solution exerted a BOD of 252 ppm. This nutrient food was also applied to a series of pilot plant sand filters of varying depths up to 30 inches. Results are presented in Figure 3.

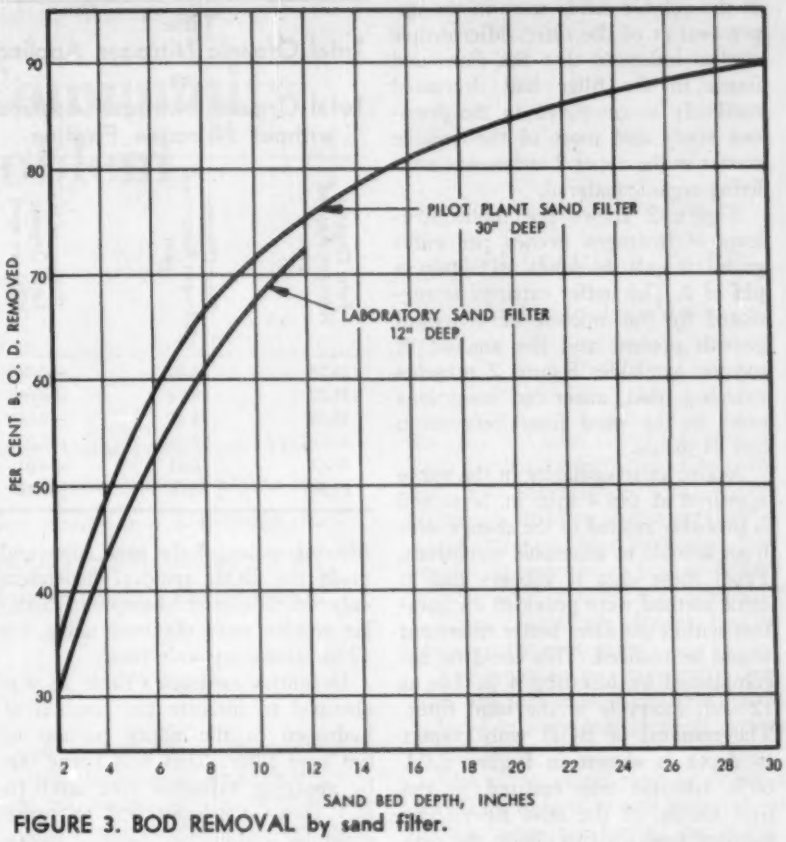


FIGURE 3. BOD REMOVAL by sand filter.

Total Nitrogen Removal

Laboratory scale sand beds of 2 in. diameter and 12 in. depth were the agencies for measuring the organic nitrogen removed. During this study results were obtained that indicated fixation of organic nitrogen. To study this further six replicate filters were constructed of glass tubes ¾ in. diameter by 12 in. long and filled with washed silica sand. Biological growth was extracted from a biologically mature sand filter, emulsified and divided into two portions. On one portion total organic nitrogen was determined and the other portion was filtered through the sand filters. The final effluent was filtered through the filter several times to insure optimum extraction of microorganisms from the suspension. The filtrate was examined for total organic nitrogen. After dosing the sand filters for three days, the total organic nitrogen content of the effluent and the organisms in the sand was determined. This value plus the total organic nitrogen in the initial liquor and that in the effluent from the nutrient feed was designated the total organic nitrogen recovered. The total organic nitrogen applied was calculated from the other portion of the biological suspension plus the organic nitrogen in the nutrient feed applied. Results in Table 1 presents the change in total organic nitrogen.

To provide further evidence of ntirogen fixation a 3 mm glass tube was inserted in each of the sand filters and 6 inches of fine sand was added above each of the filters which made the sand bed anaerobic. After feeding for one week the filtrates and the entire biological growth was examined for total organic nitrogen as above. Results are presented in Table 2.

Carbon-14 Studies:

The removal of carbon-14 labeled glucose with respect to the depth of the sand filter was studied. Preliminary work with a nutrient feed containing stable glucose plus glucose-C-14 uniformly labeled proved to be unsatisfactory. To improve utilization of the carbohydrate; glycine, alanine and urea were selected as possible nitrogen sources. Urea proved to have the most readily available nitrogen. From this preliminary work the pilot plant filter was dosed with a nutrient feed consisting of 0.05 g/1 each of glucose and urea, 0.15 g/1 of K_2HPO_4 and 0.5 microcurie = uc of glucose-C-14 uniformly labeled. Following the dosing, a 2 in. core 12 in. long was removed after 0.2, 4, 8 and 18 days. The carbon-14 activity was determined on each 1 in segment. Over a period of 3 months four replicate experiments were performed and the average results are presented in Figure 4.

Table 1
Organic Nitrogen Applied
vs
Total Organic Nitrogen Recovered with Nitrogen Fixation

Total Organic Nitrogen Applied ppm	Total Organic Nitrogen Recovered ppm	Difference in Total Organic Nitrogen ppm
37.42	37.81	+0.39
30.68	31.82	+0.14
35.27	35.68	+0.41
35.04	34.99	−0.05
35.94	36.21	+0.27
36.39	36.64	+0.25

Results and Conclusions

The results from this investigation show that most of the treatment by sewage sand filters is realized in the upper 5 or 6 inches. Figure 1 shows that at the 5 inch level there is an abrupt change in the concentration of volatile solids. A similar distribution of volatile solids has been observed in several other sand filters. From the microscopic examination of the flora and fauna of the sand bed it appears that in the depth range of 4 to 6 inches microaerophilic conditions exist. Following the termination of this study the sand bed was loaded at a rate of 400,000 gad. After the bed was clogged the distribution of the volatile solids was again determined. It was observed that most

of the volatile solids were in the upper two in of the filter. Microscopic studies indicated that the flora and fauna in the filter had decreased markedly as compared to the previous study and most of the volatile matter in the upper 2 inches was nonliving organic material.

Figure 2 shows the milliequivalents of hydrogen needed per milligram of volatile solids to obtain a pH of 3. The buffer capacity is regulated by the amount of biological growth present and the amount of oxygen available. Figure 2 presents evidence that anaerobic conditions exist in the sand filter between 6 and 24 inches.

Again, an irregularity in the curve appeared at the 4 to 6 in. level and is probably related to the change over from aerobic to anaerobic conditions. From these data it appears that if some method were provided for aeration within the filter better treatment would be realized. This could be accomplished by inserting 4 in. tile at 12 inch intervals in the sand filter. The removal of BOD with respect to depth is shown in Figure 3. A 60% removal was realized in the first six in. of the sand filter. The nutrient feed used to obtain the data for this curve contained no suspended solids which eliminated the physical filtering action of the sand filter and made the BOD removal dependent only on biological absorption. Similar results were obtained using the 12 in. laboratory scale filter.

Table 2
Total Organic Nitrogen Applied vs Total Organic Nitrogen Applied without Nitrogen Fixation

Total Organic Nitrogen Applied ppm	Total Organic Nitrogen Recovered ppm	Difference in Total Organic Nitrogen ppm
36.54	36.50	−0.06
35.72	35.76	+0.04
35.36	35.31	−0.05
37.14	37.08	−0.07
36.82	36.83	+0.01
37.28	37.18	−0.10

Definitive evidence (Table 1) was obtained to indicate the fixation of hydrogen in the upper portion of the sand filter. This was borne out by applying sufficient fine sand (6 in.) above the sand bed to cause anaerobic conditions. Table 2 shows that nitrogen fixation ceased when anaerobic conditions prevailed. Nitrogen fixing bacteria, presumably *Azotobacter*, are present in the upper layers of a sewage sand filter in sufficient quantities to fix in the neighborhood of 100 lbs. of nitrogen per acre per year. Certainly this evidence of nitrogen fixation indicates that further work is needed.

Figure 4 shows that most of the absorption of carbon-14 labeled glucose was realized in the upper six in. of the sand filter. Radioanalysis of the gasses from the filter showed that over an 18 day period 26 per cent of the carbon-14 was evolved as carbon dioxide. The remainder including the final effluent of the initial dosing was collected as soluable wastes. The evolution of CO_2 further indicates that most of the biological activity occurs in the upper layers because if the carbon dioxide were evolved in the lower portion it would be dissolved in the entrapped water and appear in the effluent.

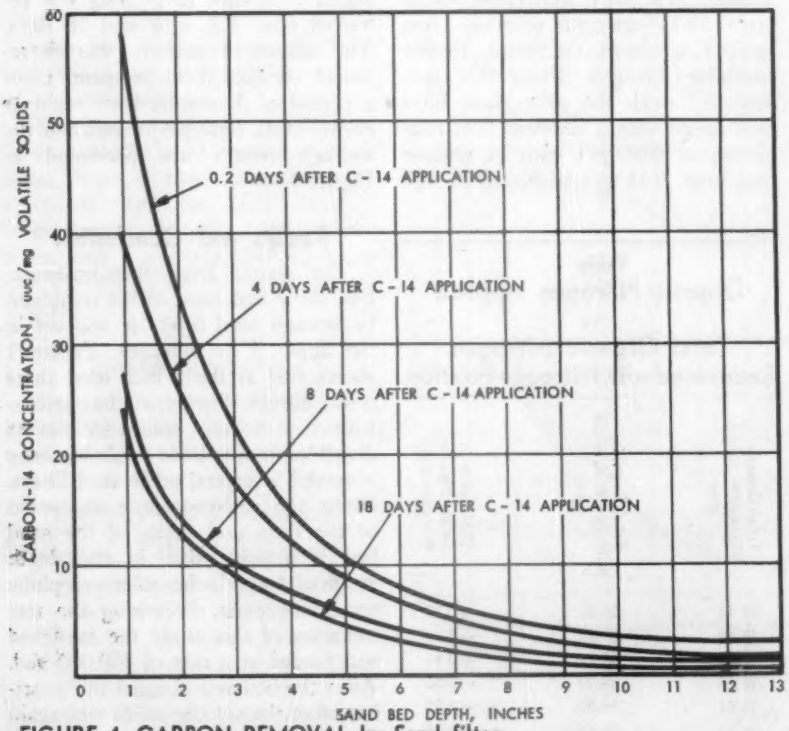


FIGURE 4. CARBON REMOVAL by Sand filter.

Summary

The distribution of carbohydrate metabolism was studied to determine the fate of carbohydrates in intermittent sewage sand filters. These studies were carried out using a nutrient feed without suspended matter which eliminated the physical removal of BOD The following results were found:

1. Most of the biological growth was located in the upper 6 in. of the sand filter. Microscopic examination indicated that at 6 in. anaerobic conditions began.
2. The buffer capacity of the bed is at a minimum from 6 in. below the surface to 2 in. above the bottom. This indicates that internal ventilation would be very beneficial.
3. Approximately 60 per cent of the dissolved BOD is removed by the upper 6 in. of the sand filter.
4. The upper portion of the sand filter contains nitrogen fixing bacteria.
5. Carbon labeled glucose is primarily absorbed in the upper 6 in. of the sand filter and undergoes decomposition there as indicated by the evolution of $C^{14}O_2$.

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Aerobic Digestion gets a foothold in Minnesota as . . .

A Suburban Community Solves a Problem

by RICHARD A. MIER
Minneapolis, Minn.

Editor's Note: Contamination of ground water from septic tanks and odor and fly problem potential from conventional plants led to installation of an aerobic digestion plant for a 250 home development near Minneapolis-St. Paul. Ownership will eventually transfer to property owners who will pay a monthly charge toward plant operation and maintenance.

■ SERIOUS WATER contamination problems confront residents of suburban areas near St. Paul and Minneapolis because of the proximity of numerous septic tanks to the underground water supply.

As the residential areas of the Twin Cities expand, housing contractors and developers are discovering it is often too expensive to connect residential sewage lines to the City sewer system. This is because of the numerous lift stations required to pump the great distance to a central sewage plant. Therefore, in many cases, they must solve their own sanitary treatment problems without municipal aid.

Ordinarily the septic tank is an acceptable solution, but contractors and residents have found that in most areas either the heavy clay soil did not allow proper percolation or that in sandy soil the sewage would seep down to the underground well supply. Numerous residential wells have been polluted with sewage, as shown by Minnesota State Health Department samples.

Developers of Cedar Grove a new suburban community did not want to risk installation of septic tanks, or a trickling filter plant with the attendant possibility of odor and fly problems. An odor nuisance from a trickling filter sewage treatment plant, or well contamination from even one septic tank could depress the value of all homes in the neighborhood. Odor or well contamination might seem of little importance in a new suburban area. However, it can become extremely serious in a few years when the area is fully developed.

Aerobic Digestion Selected

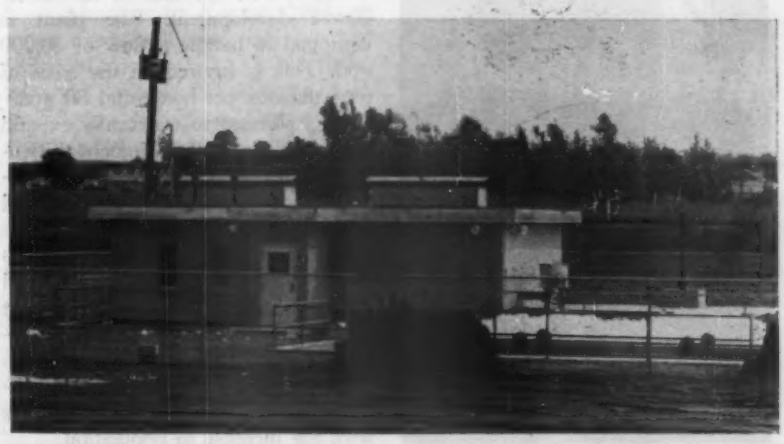
These considerations were carefully weighed early in the planning stages of the Cedar Grove development and the developers decided that a community sewage treatment plant and collection system could best serve the project. Cedar Grove's developer, Emil Jandric Construction Company, had little experience with sewage treatment facilities so the services of a consulting engineer were used. The consulting engineering firm of Robert Ellison, was retained and suggested a Rated Aeration* process for the sewage treatment plant.

The intention was to install a low-cost, efficient sewage treatment plant tailored to the needs of small groups of houses.

The plant would have to utilize a simple process to permit operation at a low cost per-house, per-month, with little attention and no odor. Other developers in the United States were able to justify both the initial and operating costs of the aeration process based on its ultimate economy compared with the cost of septic tanks and their maintenance.

The developer decided to install a concrete Rated Aeration system. This system uses an activated sludge

*Product of: The Chicago Pump Company, Chicago, Ill.



SITE of Cedar Grove Aerobic digestion plant during landscaping. Plant area is 50 square feet.

INCOMING SEWAGE passes through this 12" Barminutor.

process which oxidizes the volatile organic matter within the plant itself. The sewage is treated in three phases. First, it is fed through an automatic screening and cutting unit. From there it goes to an aeration tank where oxidation of impurities is speeded up by use of forced, diffused air. From the aeration tank, the sewage moves to a settling compartment where sludge solids are settled, producing a clarified effluent. The settled sludge is constantly withdrawn and returned to the aeration tank, where it ultimately is oxidized to a minute flaky ash. The ash material leaves the plant as suspended solids in the final effluent.

It is expected that approximately 15 man-hours per week will be required for maintenance. The part-time operator's duties will include service of equipment and maintenance of records for state regulatory bodies. A family living in Cedar Grove will have no individual maintenance problems even when garbage disposals are used. This disposal plant, the first of its kind to serve a Minnesota housing development, together with the sewer collection system will add about $700 to the price tag of the lots but will eliminate the cost of septic tank installations. However, it was noted that the cost of installing the average septic tank system is $500. Therefore the buyer would be paying only $200 more for the sewer collection and treatment service. Aeration and maintenance is expected to cost each home owner about four dollars per month.

A question of interest other developers who may use the same treatment process is, "who will own the plant and how will the developer recover his investment?"

Association Organized

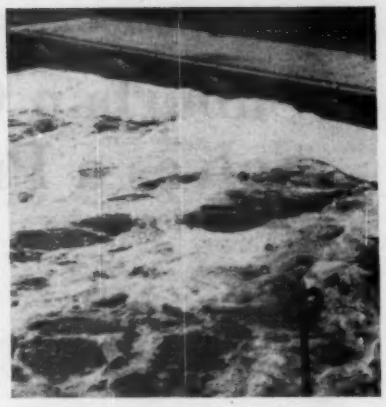
The restrictions against the development area were written to include details for setting up an association of future lot owners. The Cedar Grove Utilities Corporation was organized of which each lot owner automatically becomes a member. The developer expects to recover the cost of the plant and sewer system in the price of the lots. In a few years the sewage treatment facilities will become the property of the association and the residential owners.

As designed, the plant will more than adequately handle the 250 homes which it now services in the Cedar Grove development. The plant is equipped to handle a flow of 80,000 gpd. This is figured on the basis of four persons per-home and 80 gpd.

It is planned to eventually expand the Cedar Grove development to two-thousand homes. To the basic concrete plant may be added aeration and settling tanks, sludge filters or digesters and drying beds, when expansion becomes necessary. This will result in savings on the overall cost of construction of a complete system. As the plant is expanded to meet the demands of the growing suburb it can be financed in stages with the increase in population.

The builder believes there will be no opposition from the residents to the plant because this type aeration plant does not develop odors. The plant is set 200 yards from the homes and empties treated sewage effluent into the Minnesota River. The effluent is considered safe by Minnesota health officials.

VIEW LOOKING down on sewage pumps. Space is for future expansion.



AERATION TANK during plant operation. Note header and spray nozzles for froth control.

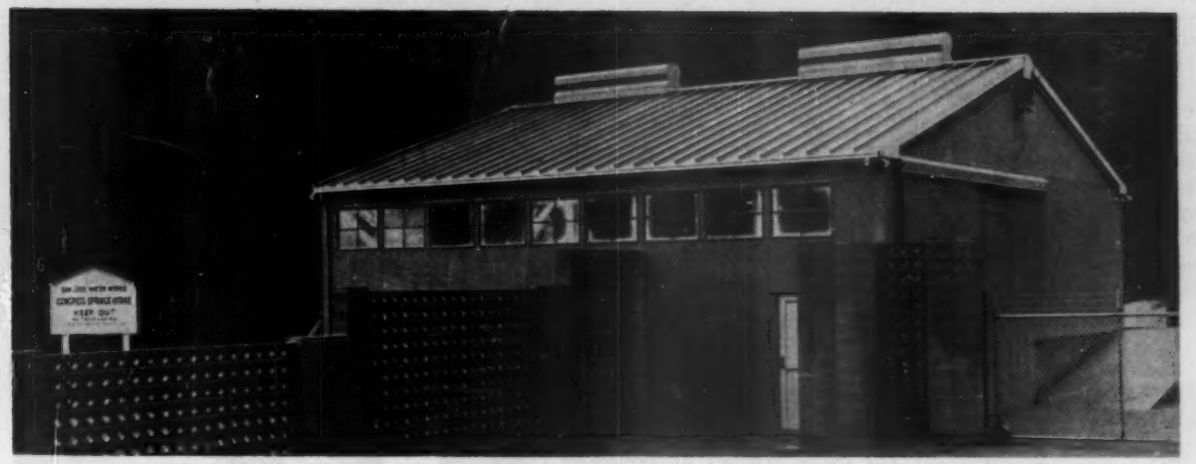
The complete plant equipment will be housed within an area 50 feet square and will include a lift station, two aeration tanks, two settling tanks, one chlorination tank and one sludge holding tank. The plant will be enclosed by a six-foot chain link fence and surrounded by an attractive hedge. The community as well as the individual home owners will benefit by the elimination of the maintenance and odor problems often encountered in areas serviced by septic tanks, sludge lagoons or trickling filter plants. This in turn will help to maintain the property value of Cedar Grove.

NEXT MONTH

W&SW

presents its Annual equipment photo review of Progress in

WATER AND SEWAGE WORKS



This small building houses a 5-mgd water filtration plant employing . . .

Versatile Diatomite Filters

by N. J. KENDALL, Chief Engr.
San Jose Water Co., Saratoga, Calif.

EDITOR'S NOTE: Four fully automatic diatomaceous earth filters are installed in the building shown above. The limited space requirements, variable flow rates plus varying raw water quality, the automatic controls and the advantage of using intake pumps also as filter pumps, have made this diatomite filter plant an economical method for supplying municipal water needs.

■ A FULLY AUTOMATIC diatomaceous earth filtering system has been placed in service at Saratoga, Calif. The system rated at 5 mgd, is designed to treat water from a mountain stream for domestic use. Fresh water supplies previously obtained from deep wells are now used as auxiliary resources.

The increasing demand for water forced the San Jose Water Co., to develop surface water resources existing as streams in the steep mountain canyons. The lack of room prevented economic construction of large water treatment facilities and thus the diatomaceous earth system without any pretreatment was tried. The original plant was constructed at New Almaden in August, 1957, as a test plant. Although only rated at 185 gpm (1.6 gpm/sq. ft. of filtering area), this plant produced as high as 260 gpm during peak hot weather consumption periods. In winter, after storms, the raw water received at this plant often had a turbidity exceeding 100 mg/l.

The experience at New Almaden led to the construction of a similar plant at Saratoga. The Saratoga plant is 20 times larger and employs four automatic filters which can operate in any combination to produce a rated plant output of 3500 gpm.

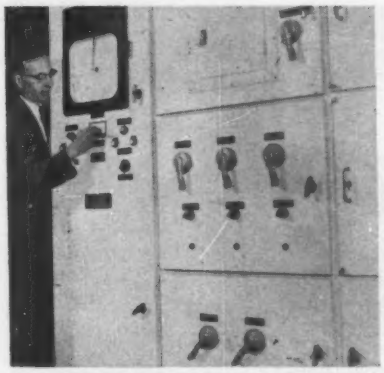
Objectives of Saratoga Plant

The filter plant, located on a mountain stream, serves as the main or base load water source for the San Jose Water Co. The plant takes all the water available from the stream. In the summer the stream flow is minimal, therefore the company relies on deep wells as the source of water.

The cost of pumping water from deep wells, located in the valley, is comparable to the mountain filter plant costs, only when the turbidity of the mountain stream reaches 50 mg/l. Well pumping is expensive; therefore, is used as little as possible.

Stream Water Quality

The mountain stream supplying water to the Saratoga filtering plant is not subject to contamination by human sewage. The turbidity of the water is induced by normal run off and increased at times by road construction, road maintenance, and similar activities upstream. During the dry season the turbidity of the raw water ranges between 5 and 10 mg/l. The rainy season causes the



CONTROL PANEL regulates operation of the diatomaceous earth filters at the Saratoga plant. N. J. Kendall, Chief Engr., San Jose Water Co., makes adjustments.

turbidity to increase to 50 mg/l or more.

In years of normal rainfall, the stream has maintained a flow of 5 mgd both winter and summer. Recently, the rainfall has been low and the stream is producing only about 1.5 mgd. These seasonal stream flow variations require the filter plant to operate accordingly.

Pumps, located at the stream, lift water from the intake well and serve also as filter pumps. The pumps have variable-speed drives and regulate output according to available input during periods of low stream flow.

Filter Plant

The entire plant can be operated on a wide variation of flow rates using various combinations of the four available filter units. The operator merely sets the flow rate desired and the plant automatically adjusts. The flow rate is usually set slightly higher than the minimum actual flow in the stream. This causes the level in the wet well to drop periodically requiring the plant to go on recirculation until the wet well level is restored. In this manner, the unattended plant is able to catch every available drop of water coming down the stream. The recirculation prevents any loss of filter cake or plant disruption due to the lack of available input.

Precoating and backwashing of filter systems is automatic. Diatomaceous earth is fed continuously during filtering runs at a controlled rate and the filter is automatically taken out of service when the predetermined maximum pressure differential, or minimum filtration rate, is reached. The backwashing and precoating operations require about 15 minutes.

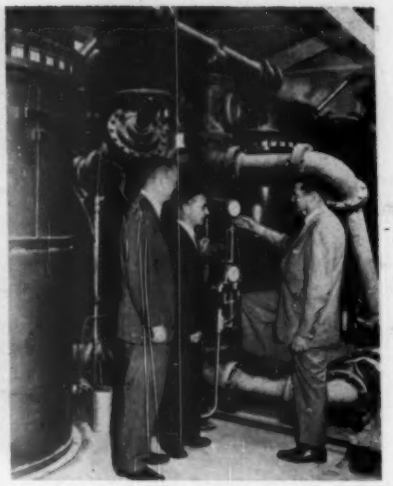
The filter runs average 72 hours on water with low turbidities and decreases down to 6 hours on very turbid water.

The operating costs vary accordingly. Low turbidity waters average about $6.00 per mg and increase to around $30.00 per mg when the turbidity is more than 50 mg/l. At turbidities over 200 mg/l the cost of water is somewhere around $150 per mg, but well pumping can be relied upon during any short periods of adverse stream conditions, such as these.

Filter backwash is retained in a sludge pit where the solids are permitted to settle and the clear water returned to the stream. Settled sludge is removed about once a year; settled water is drawn from the pit once a day. The volume of backwash amounts to less than 1 gal per 1000 gal treated; therefore, a sludge pit measuring 50 x 15 x 5 ft has served very well.

Safety controls prevent any filter going on line until it is properly precoated. Likewise, the plant fails safe on any power interruptions.

The only manual operations required are the refilling of diatomaceous earth slurry tanks and assuring a chlorine supply. This can usually be accomplished by one visit each day by company personnel.



RELATIVE FILTER SIZE is shown by the presence of Sam Felix (left), De Laval Turbine Pacific Co.; N. J. Kendall and Charles B. Parbury of the San Jose Water Co.

Both the New Almaden and the Saratoga filter installations are of the package type which are also used in many industrial applications. Treated water effluents from these units normally have zero turbidity and realize at least 85 per cent reduction of bacteria before chlorination. The filtration system plus post chlorination have provided the citizens of Saratoga, Calif., a versatile method of economically supplying their need for water.

The filter installation cost of the Saratoga plant, including wet well, slabs, building, inlet and outlet headers, and piping from pumps to the filter plant and sludge pond amounted to $150,000.

—Photos were furnished by the DeLaval Turbine Pacific Co.

Reservoir Proposed for Northeast Missouri

The authorization of a proposed $55 million Joanna Reservoir as a multi-purpose project on the Salt River in northeast Missouri was recently recommended by the U. S. Army Engineers.

The recommendation came in a report by the St. Louis District Engineer and the Lower Mississippi Valley Division Engineer at Vicksburg, Miss., submitted for review to the Board of Engineers for Rivers and Harbors in Washington, D. C. The Engineers said that the reservoir could be used for flood control, power, navigation water supply, recreation, and fish and wildlife conservation.

In addition, the project would provide flood protection to 27,500 acres of land in the Salt River basin, reduce floods in the upper, middle and lower Mississippi River, and provide an annual generation of almost 49,000,000 kilowatt hours of electric power.

The reservoir also would provide a source of water to meet anticipated future municipal and industrial water needs, as well as attract a large number of tourists. Under their recommendations, provision would be made to permit installation of a second generating unit if warranted by economic conditions.

The report said local interests would be required to contribute 24.53 per cent of estimated initial construction cost of more than $55.8 million for the Joanna Reservoir, plus 10.79 per cent of the annual maintenance and operation cost.

Cool, Clear Water for Camp Lejeune

"Old Dan and I with throats burnt dry, and souls that cry for water, Cool, clear water . . . . ."

Patrick Henry Barker, Camp Lejeune Water Works Superintendent, could throw one whale of a party for this lamenting cowpoke.

From his office at Bldg. #20 on the 111,000 acre Marine Corps Base, Mr. Barker supervises the production and treatment of almost nine million gallons of water daily. Many say this vast project provides the finest drinking water on the eastern seaboard of the United States.

Water production and treatment is an operation that reaches every building, home and person at Camp Lejeune. The operation utilizes 27 men, 100 buildings, miles of pipe, a fully equipped laboratory, and a maze of highly technical hydraulic valves and IBM machines.

Treatment plants are located at Hadnot Point, Montford Point, Tarawa Terrace, Camp Gieger and Onslow Beach. Smaller water pumping systems are at Courthouse Bay, the Rifle Range and at the Amphibian Base near Courthouse Bay. Base Water Works is also responsible for the operation and maintenance of four swimming pools here.

Mr. Barker has been associated with water plants for 33 years. He worked at the water plant in Greensboro, N.C. 15 years before Civil Service accepted him for the Camp Lejeune job in November 1942. His assistant, Mr. Claude D. Chadwick, began at the same time, and the two men have worked together for almost two decades. Barker, Chadwick, and their Chemist, Mr. Leon A. Justice, are not reluctant to explain their water plant operation.

First, raw water is pumped from 35 wells located at various places around Hadnot Point to an underground reservoir at the plant. Chlorine to kill harmful bacteria is added to the raw water as it flows into the reservoir. Turbine type pressure pumps lift the raw water out of the reservoir, up through five Spiractors* where it is treated and softened.

To soften water, cold lime is added at the base of the cone shaped units. The water-lime mixture surges upward through a layer of beach sand which removes calcium and iron from the water. Lime raises the alkalinity of the water causing dissolved calcium and iron deposits to become solid forms. These solid calcium and iron deposits stick to the grains of sand when the swirling water brings them in contact with each other.

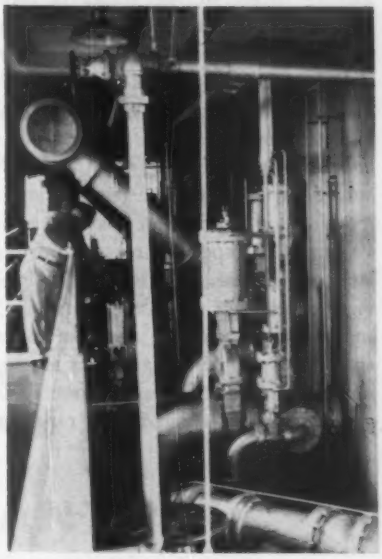
At the top of the cones, the water now flows out to a settling basin, and then into five rapid sand and gravity type filters. These filters remove turbidity, lime and iron remaining after the softening process.

The water, now ready for consumption, goes into two underground reservoirs that have a combined capacity to hold almost three million gallons and is distributed by high-lift service pumps as needed. The average consumption rate at Camp Lejeune is 3,500 gallons a minute. Of course the consumer needle jumps higher about 6:30 a.m., when most of the camp's personnel start taking showers and perk coffee; the needle drops furthest after bedtime.

Chemist Justice said the water here is as good as a highly regarded mineral water now being sold to health cults at substantial prices. One difference is that the popular mineral water flows through underground deposits of magnesium sulfate heptahydrate. In every-day-language, that's Epsom salts.

*Product of Permutit Co., New York, N. Y.

FINAL PHASE of water treatment occures in this spotless room where five rapid sand and gravity type filters remove turbitity, lime and iron remaining after the softening process in the Spirators.



VALVES and instruments need precision adjustments 24 hours a day, seven days a week. The size and operation of the plant here is capable of serving a city of 75,000 people.

EDITORIAL

Stop Talking and Start Working

The last half of 1960 has been marked by three significant events in the area of water pollution control. While the AWWA sections, WPCA's, WPCF, APHA, and others held their usual meetings, the U. S. Public Health Service engaged in three which could have vital importance in the years ahead.

The first of these was the early August Lagoon Symposium in Kansas City, Missouri. While no precedent-shattering conclusions were reached, the subject was exhaustively discussed and attendees reported genuine progress was made. It remains, however, for future work to be done in order to firm up design standards and criteria pertinent to this important means of pollution control. Since the USPHS sponsored the symposium, it naturally follows that the service should similarly follow through and superintend production of the necessary guidelines.

Next, the USPHS sponsored a symposium on Water Quality and Instrumentation in the Robert A. Taft Sanitary Engineering Center's backyard, Cincinnati, Ohio. Held late in August, it attracted 300 high-powered professionals and technicians. Unfortunately, the substance of the presentations failed to disclose anything new, other than ORSANCO's Robot Monitor. The presentations, did, however, reveal a glaring defect in the status of our present fight to master surface water pollution and control. The glaring defect lies in the area of instruments with which to *detect* pollutant presence. The past feeble, time-consuming methods of sampling, transport and wet analysis continue, in a sort of horizontal, suspended animation rate of progress. The problem has not been solved by continual attempts at transferring, with modification, equipment spawned in industry, after development for specific process control applications. This lack of original thinking in developing analytical devices strictly for steam monitoring is regretable. It has resulted in much time spent in manual collection and analysis of usually insignificant amounts of increasingly important data. These continue to be our only background against which future results can be compared.

Perhaps the third significant event, the USPHS National Conference on Water Pollution meeting in Washington, D. C., December 12-14, 1960, will bring this and other pollution control problems into sharper focus. Unfortunately, a large part of the expected 1,000 attendees have not been exposed to repetitive written and spoken words about the critical nature of this overall problem. These people represent National organizations whose efforts are normally directed elsewhere. The Conference will first attempt to bring them up-to-date, re-emphasize the impact of environment on our water supply and describe how pollution abatement can make more water available to those who need it.

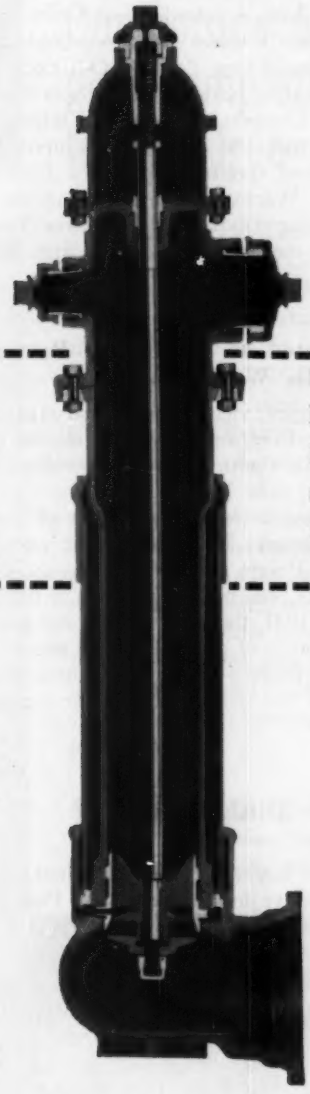
Finally, the Conference may have time to reach Secretary Flemming's September, 1960, goals: "obtain substantial agreement (1) on National goals for water pollution control, and (2) on the specific programs to reach these goals". The Conference theme, "Clean Water—A Challenge to the Nation", does not leave much to the imagination. It clearly states an attainable National goal, if the common definition of 'clean' is acceptable. What is not clear and what does need thorough working over is a list of specific programs to make our Nation's water clean.

There are reasons why such a Conference as this is needed. If we meet the present challenges with successful solutions to the water supply problem, we must never be allowed to fall so far behind again. One of our greatest needs has been the stimulus to apply new techniques and tools as they become available. This implies a need for personnel with the desire to improve practices and procedures. It also implies the need to know specifically what compounds and complexes of compounds constitute pollution when released to our watercourses.

Perhaps it is expecting too much from a Conference of 1,000 people to digest all pertinent facts one day and make concrete recommendations the next. But one thing is certain: "clean water" will remain "A Challenge to the Nation" until we stop talking and start working.

V. W. Langworthy

ONLY MATHEWS HAS ALL THE DESIRABLE FEATURES



What do you look for in a hydrant? Dependability... replaceable barrel?... conventional packing?..."O" ring seal?...stop nut to prevent stem from buckling? We could double this list and still not cover all the features we build into Mathews Hydrants *by design.* Mathews has them all.

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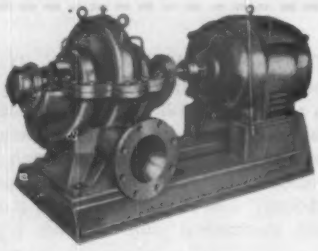
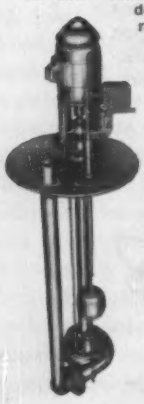
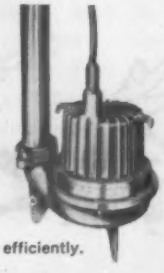




. . . and, to handle drainage pumping from low to higher level, they look to Weinman's line of Vertical, Submerged, Non-clog Sewage Ejectors. These proven municipal workhorses pump raw sewage and other waste materials without clogging.



. . . or, for permanent or portable sump installations, the Weinman Type M Non-clog, Immersible Pump handles sewage, industrial wastes and drainage water swiftly and efficiently.

So, for a ready solution to growing water problems, consult your Weinman Specialist. He's listed in the Yellow Pages. Or, write direct for descriptive literature.

THE WEINMAN PUMP MFG. CO.
270 SPRUCE STREET COLUMBUS 15, OHIO
CENTRIFUGAL SPECIALISTS

News of Suppliers

Smith & Loveless Adds Canadian Plant

Smith & Loveless factory-built sewage lift stations and sewage treatment plants will be manufactured in Canada as well as their Lenexa, Kansas plant, beginning this fall. A new Canadian company will be formed as Smith & Loveless Company, Division-Products Tank Line of Canada, Ltd., a subsidiary of Union Tank Car Company. The new division will have headquarters at 866 Lakeshore Road, New Toronto, Ontario.

The steel fabricating facilities of Products Tank Line's Sparkling Tank Division at Oakville, Ontario, will be used to manufacture the company's equipment to the same standards and specifications of the United States affiliate. W. A. Wachsmuth, manager of the Fraver Water Conditioning Division of Products Tank Line, will also manage the Smith & Loveless firm in Canada.

Swingley Elected to Controller Post of Indianapolis Water Company

Ralph L. Swingley, vice president and controller, Indianapolis Water Company, has been elected treasurer of the Indianapolis Control of the Controllers Institute of America.

Upon completing a term as president of the Puerto Rico Control, Antonio E. Lebron, first executive director (finance), Puerto Rico Water Resources Authority, San Juan, has been made a director of the group.

Established in 1931, the Institute is a non-profit management organization of controllers and finance officers from all lines of busines—banking, manufacturing, distribution, utilities, transportation, etc. The total membership exceeds 5,200.

CIPRA Names Dittig Eastern Representative

Appointment of Roger G. Dittig, Jr., Bethlehem, Pa., as field representative for the Cast Iron Pipe Research Association has been announced by Thomas F. Wolfe, managing director.

Dittig's appointment was occasioned by an expansion of the Association's technical advisory service to water utility executives and consulting engineers.

He will serve the New England states and Pennsylvania, New Jersey, New York, Delaware and Maryland, and have his headquarters in Bethlehem, Pa.

Before coming to the Association Dittig was assistant professor of civil engineering courses at Lehigh University.

Previously, he was employed by Hazen & Sawyer, and by Malcolm Pirnie Engineers, New York City, specializing in sanitary engineering. He is a member of A.W.W.A. and the National Society of Professional Engineers.

Mrs. Barbara E. Hawkes, Chief Chemist, checks backwashing of Billerica's #1 filter.

WILLIAM KERIVAN, Chief Filter Plant Operator, Billerica (Mass.) Water Treatment Plant, says:

"Our porous underdrains give completely trouble-free service..."

The Billerica Water Treatment Plant serves 26 square miles, supplying 1.0 MGD from the Concord River. Beds for Billerica's four filters are 30" of sand and 18" of anthracite, with ALOXITE® aluminum oxide porous bottoms. Average load is 1.5 MGD and 2.0 MGD during peak periods.

"What we like most about the ALOXITE plates," says Mr. Kerivan, "is that we have none of the problems of graded gravel. For example, the large photo, taken during backwashing, clearly shows no blow holes such as you run into with an upset gravel bed. Scum is removed easily and uniformly. As for mudballs, they're just a name to us—we don't have them.

"The porous plates have had no repairs since they were installed four years ago. Their only maintenance consists of acid cleaning once a year. Judged from our experience, these bottoms have no shortcomings."

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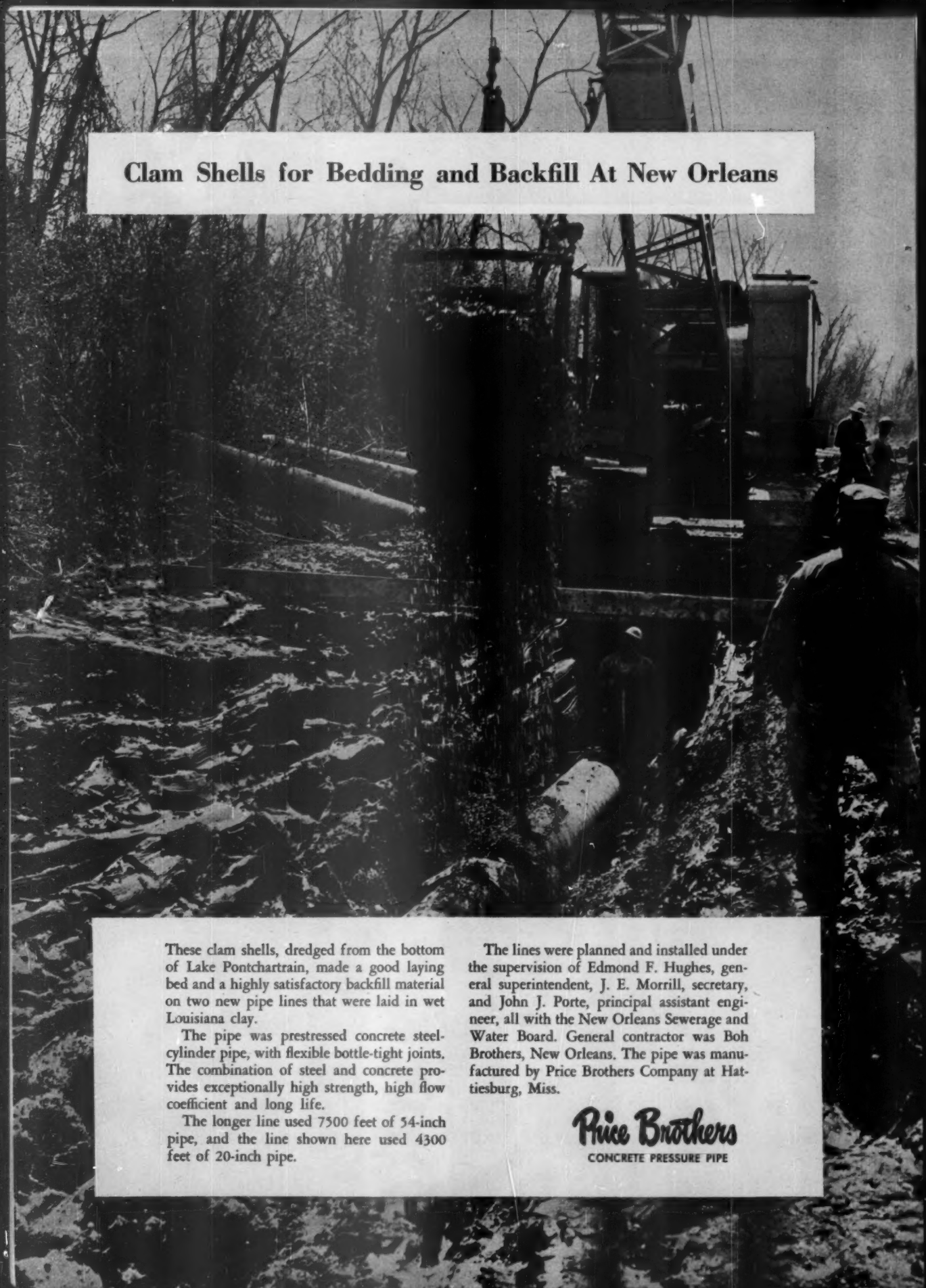
Registered Trade Mark

Dept. X-120, Refractories Division, Perth Amboy, N. J.



Clam Shells for Bedding and Backfill At New Orleans

These clam shells, dredged from the bottom of Lake Pontchartrain, made a good laying bed and a highly satisfactory backfill material on two new pipe lines that were laid in wet Louisiana clay.

The pipe was prestressed concrete steel-cylinder pipe, with flexible bottle-tight joints. The combination of steel and concrete provides exceptionally high strength, high flow coefficient and long life.

The longer line used 7500 feet of 54-inch pipe, and the line shown here used 4300 feet of 20-inch pipe.

The lines were planned and installed under the supervision of Edmond F. Hughes, general superintendent, J. E. Morrill, secretary, and John J. Porte, principal assistant engineer, all with the New Orleans Sewerage and Water Board. General contractor was Boh Brothers, New Orleans. The pipe was manufactured by Price Brothers Company at Hattiesburg, Miss.

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CONCRETE PRESSURE PIPE

It's MORE than just "different"....

This DeZURIK VALVE gives you SOLID ADVANTAGES you get in NO OTHER VALVE!

TIGHT SHUT OFF—Resilient plug facing provides a cushioned closure that seals tight—even on solids in the flow!

EASY OPERATION—The plug touches the valve body *only* in the closed position; there is no binding; no scraping!

NO "FREEZE-UP"—Bearing bushings in the journals prevent freeze-up due to corrosion even after long periods of inoperation!

NO LUBRICATION—The resilient plug facing and eccentric action eliminate the need for lubrication to assure tight shut off or easy operation!

LONGER LIFE—The high nickel alloy seat—the corrosion resistant bearing bushings—the resilient plug facing all contribute to longer life on the toughest services!

LOW PRICE—Size for size, DeZurik Valves are the best valve value. They cost less initially and they cost less to maintain.

There are other advantages to DeZurik Valves. Their compact size makes installation easier, especially when the valve is equipped with an actuator. Their leak-proof stem seal is self-adjusting and does not need periodic maintenance. For these . . . . and so many other reasons . . . . DeZurik Eccentric Valves are being installed in a constantly growing number of plants. Why not have these advantages in *your* plant?

Available in sizes ½" thru 24", with a full complement of actuators. Write for catalog.

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SARTELL, MINNESOTA

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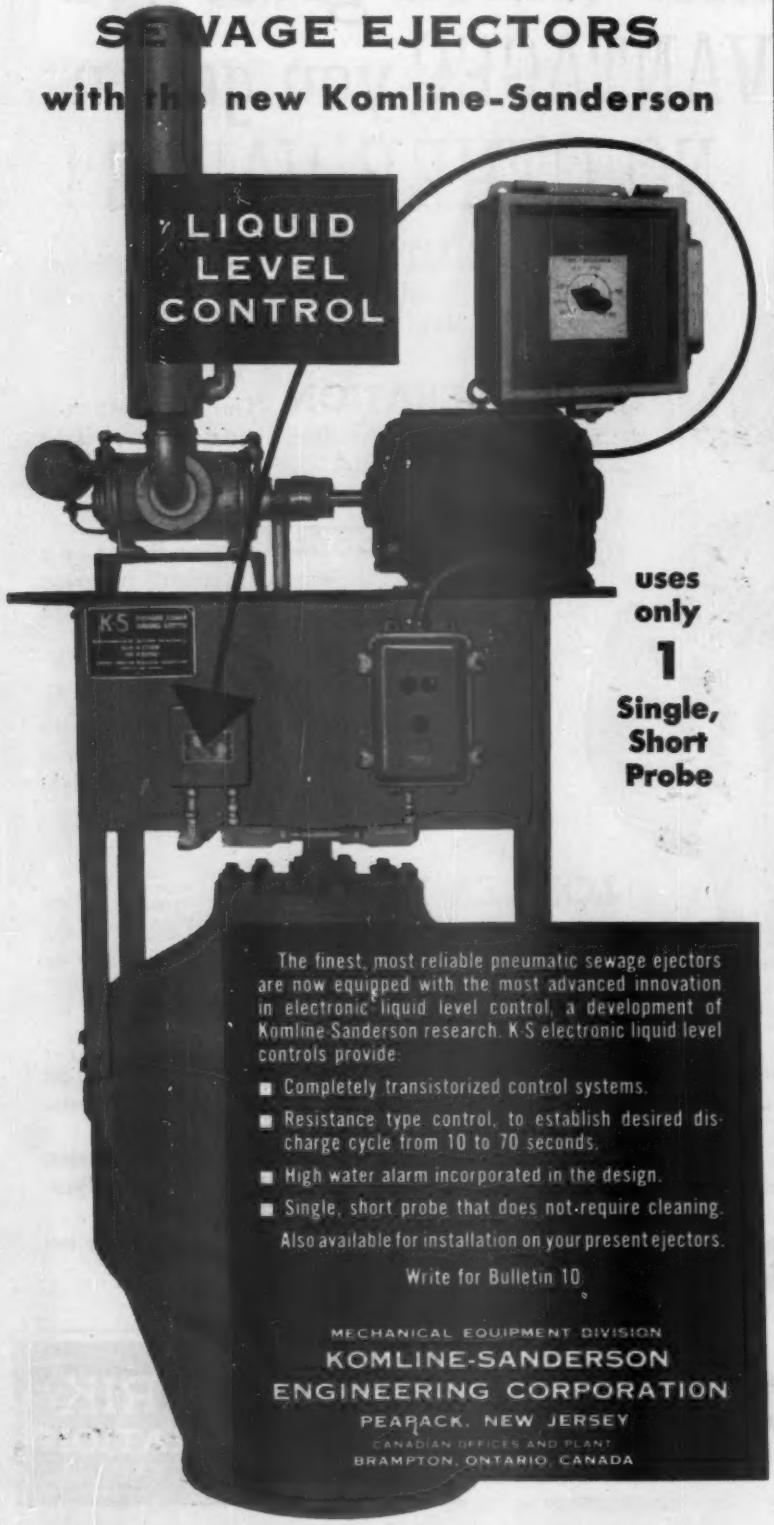

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The finest, most reliable pneumatic sewage ejectors are now equipped with the most advanced innovation in electronic liquid level control, a development of Komline-Sanderson research. K-S electronic liquid level controls provide:

- Completely transistorized control systems.
- Resistance type control, to establish desired discharge cycle from 10 to 70 seconds.
- High water alarm incorporated in the design.
- Single, short probe that does not require cleaning.

Also available for installation on your present ejectors.

Write for Bulletin 10

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KOMLINE-SANDERSON ENGINEERING CORPORATION
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CANADIAN OFFICES AND PLANT
BRAMPTON, ONTARIO, CANADA

New Bulletins

Engineering Manual for Pumps

1219

Marlow Pumps, Div. of Bell & Gossett Co., Midland Park, N. J., is offering a 40-page Engineering Manual designed to provide the answers to problem-questions regarding pump selection, installation and application.

Most of the data is presented by means of charts, tables and graphs. The manual is indexed for reader convenience, and its information was compiled from various manufacturers' data, engineering handbooks, practical experience and laboratory tests.

A Micro-Straining Story

1220

Glenfield and Kennedy, Inc., Harrison, N. Y., announces the availability of a 4-page bulletin that outlines the installation and performance of a micro-straining plant at Marston Lake, a source of Denver's water supply.

On-the-job photographs illustrate how the installation was made and how the micro-straining project operates.

Torque-Flow Pump

1221

Wemco, Div. of Western Machinery Co., San Francisco, Calif., has announced the availability of a new 6-page bulletin that describes its Torque-Flow pump. In this unit, both the suction and discharge waterway are one continuous passage and there is no separation between suction and discharge pressures.

The bulletin is divided into sections that explains, How It Works, Why It Works, and Where It Works. Illustrations are provided by diagrams and on-the-job photographs.

Zimmermann Process Described

1222

Zimmerman Process Div., Sterling Drug, Inc., New York, N. Y., describes the operation of the Zimmermann Process of sewage sludge in a new brochure recently published.

Titled, "Waste is for Burning . . . Without Flame", the publication explains how the Process burns sew-

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age sludge in its aqueous state, without flame. Included in the technical data provided in the brochure are a flow chart, conversion chart, equipment and operational results, various design data and other material.

Sludge Collectors

1223

Link-Belt Company, Colmar, Pa., is offering a 28-page publication that provides comprehensive engineering data on its Straightline sludge collectors.

The book contains capacity and selection tables, together with specifications, drawings and illustrations of the units. The adaptation of these units to conventional rectangular settling tanks, to Uniflow tanks and to preaeration-settling tanks is shown.

In addition, motorized and hand-operated skimmers for scum removal and sludge withdrawal valves for continuous sludge removal are also illustrated and described.

"Water Bill U.S.A."

1224

Caterpillar Tractor Co., Peoria, Ill., tells the story of water and the huge money outlay necessary to pay the country's annual water bill each year in a new, 16-page booklet recently released.

The booklet, intended as a promotion piece for water utilities, discusses the problem and explains ways by which Americans are working to solve it with better farming practices and watershed control programs.

Automatic Drive Controls

1225

Centric Clutch Co., Woodridge, N. J., has recently published an 8-page bulletin entitled, "Modern Clutching for Water and Sewage Treatment Plants". The bulletin, which comprehensively explains and illustrates automatic drive controls, is especially written for water and sewage executives, engineers and consulting engineers.

Various types of drives used in water and sewage plants are described by means of typical layouts of mechanical drives, informative text, dimension tables and illustrations.

Automatic Analysis of Water Hardness

1226

Technicon Controls, Chauncey, N. Y., announces the availability of a 2-page data sheet that describes the methodology for the continuous, automatic analysis of water hardness with its AutoAnalyzer system.

The system is illustrated by a flow diagram and the actual recording of hardness in ppm is shown.

Steel Grating and Treads

1227

Kerrigan Iron Works Co., Nashville, Tenn., is offering a 12-page bulletin that details the types and applications of its steel grating and treads.

Photographs show various plants

CONTINUED ON PAGE 90A

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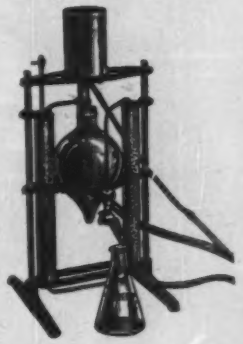

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Williamsport 11, Pa.
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New Bulletins

CONTINUED FROM PAGE 89A

where this equipment has been installed. In addition, the bulletin includes various tables by which proper grating may be computed, and drawings illustrate how the various types of grating and treads are constructed.

Dry Chemical Feeder

1228

Infilco Inc., Tucson, Ariz., has released a new bulletin that discusses the mechanism and operating principles of the company's type "G" Gravimetric chemical feeder. This unit handles all dry chemicals normally used in water and waste treatment, whether the chemicals are in powder, granule or lump form as large as ¾ in. in diameter.

Other features described in the bulletin are the electrical and operating controls that are integrally built into the unit, and the agitators within the hopper that prevent "arching" or hold-up of chemicals.

Continuous Fluoride Feeder

1229

B-I-F Industries, Providence, R. I., has issued a new, 4-page bulletin that presents the most recent data on the Omega Fluoridizer designed for the accurate, continuous, volumetric feeding of fluoride com pounds.

Illustrated with photographs and a dimensional diagram, the bulletin outlines the principle features of the unit, describes its operation and lists the various accessories that make the unit applicable to a number of job functions.

Positive Displacement Blowers

1230

Sutorbilt Corp., Compton, Calif., has announced the publication of a 12-page bulletin that describes how its California Series of horizontal and vertical blowers and gas pumps automatically provide a metered quantity of oil-free air at constant volume, even against variable pressure.

Complete dimensional information on all models and sizes is given by means of charts and drawings.

WATER CHEMIST—Concord, California. Salary open. New Position, allows individual to obtain necessary lab equipment and establish procedures to personal specifications. Initiative required. Administrative responsibilities available as supervisor of water treatment facilities. Send resume to Contra Costa County Water District, Pittsburg, California.

WATER ENGINEER—Concord, California. Salary $600—$750. New position of supervisory, design, and planning nature. California registration required, C.E., M.E., or E.E. or equivalent degree. Send resume to Contra Costa County Water district, Pittsburg, California.

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Performance data for low pressure, medium and high pressure units are also presented.

Aerobic Digestion Plants

1231

Eimco Corp., Salt Lake City, Utah, has published a new, 12-page bulletin that discusses aerobic digestion, a simplified treatment process which, using the company's equipment, is designed to achieve 85 to 95 per cent suspended solids and BOD reductions in approximately 28 hours treatment time.

Diagrams, tables and on-the-job photographs illustrate the operation of the process and the performance ratings of the equipment. Specifications are also included in the bulletin.

Liquid Chlorine

1232

Pennsalt Chemicals Corp., Philadelphia, Pa., is offering an informative 24-page data book that discusses liquid chlorine, its properties, containers and handling.

For convenience of reading and fact-finding, the publication is indexed according to subject matter presented. The main chapters are: Properties of Chlorine, Cylinders, Multiple-Unit Tank Cars, Single-Unit Tank Cars, and Piping and Fixtures—Handling Leaks.

A list of measurement equivalents and a list of products are also included.

Pipe Line Catalog

1233

Evans Pipe Co., Uhrichsville, Ohio, has issued a 40-page complete line catalog that lists the sizes and dimensions of standard strength, extra strength, perforated, and double-length vitrified clay pipe; Wedge-Lock clay pipe with plastisol double-ball joint; Wedge-Lock type "O" clay pipe; standard, special and Wedge-Lock fittings; and related clay products.

Replacement Chart Paper

1234

Judson Bigelow Sales Div., Techni-Rite Electronics, Inc., Providence, R. I., has issued a 14-page catalog of replacement strip chart papers. A complete listing of replacement charts for all makes and models of recorders is included with cross references to recorder manufacturers' model numbers.

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STILL LOOKING

for the answer to that problem that won't go away?

Perhaps one of these suggestions will help*

1235

Activated Silica Sols Preparation—Series Sheet "A" covers jar test procedures for preparing activated silica sol from sodium silicate and ammonium sulfate as the reacting chemical. Sheet "B" details procedures for batch preparation of activated silica sol with such reactants as ammonium sulfate, alum, chlorine etc. Illustrations show flow diagrams.—Philadelphia Quartz Co.

1236

Asbestos-Cement Pressure Pipe—4 page folder AP-17 describes advantages and features of asbestos-cement pressure pipe stressing the importance of "clear, full-flowing water—a community's most important asset".—Keasbey & Mattison Co.

1237

Clarifier—Bulletin #126, 32-pages with the theory, operating results, and necessary tables and charts required to design and specify the Lakeside Spiraflo Clarifier.—Lakeside Engineering Corp.

1238

Control Panels—New brochures describe various types of controls for integrating any vented tank system, pressure tank system or tankless system for water, waste or industrial processing and telemetering.—Autocon Industries, Inc.

1239

Copper Sulphate—A 13-page booklet describing the use and application of sulphate in water treatment and algae control, and containing charts of chemicals required for various treatments.—Tennessee Corp.

1240

Engines—A series of 4 bulletins describing Roiline 6, 8 and 12 cylinders gas engines in a range of sizes up to 685 hp. These engines are capable of operation on natural gas, butane, sewage gas, gasoline or a combination of any two of these fuels.—Waukesha Motor Co.

1241

Financing Water and Sewage Works—This booklet is designed planning and financing water and sewage works. It points out the need for sanitation facilities and stresses the revenue bond method of financing. Also discussed are factors to be considered in a determination of fair rate schedules for water and sewage charges.—Portland Cement Association.

1242

Industrial Waste Treatment—66 page catalog outlines entire line of equipment for industrial waste treatment.—Jeffrey Mfg. Co.

1243

Meter Repair—This complete, well illustrated 16-page manual for the water meter shop tells how to set up a repair and test program, how to lay out the shop, and step-by-step repair instructions. Indicate frost-proof or split case meters.—Neptune Meter Co.

1244

Municipal Sanitation—Bulletin No. 6043 "Seven Developments for Municipal and Industrial Sanitation" assembles for review in a single brochure data on seven major D-O equipment designs and process developments introduced in the past three years. It includes photographs, line and wash drawings and descriptive sketches of each development.—Dorr-Oliver Inc.

1245

Plug Valve—Folder describes the new ORISEAL Valve. This maintenance free valve is permanently lubricated and is easy turning in large sizes even aftre long periods of use.—Mueller Co.

1246

Reactor-Clarifier—New 24-page Bulletin SM-1006 describes versatile reactor-clarifier treatment units for obtaining high removals in the pre-treatment of sewage or for secondary treatment of sewage with chemical coagulants. Built in a wide range of types and sizes, including units suitable for treating industrial wastes to condition the water for re-use.—The Eimco Corp.

1247

Settling Tanks—An improved settling tank design, the Uniflow, for removal of solids from water, sewage and industrial wastes, is described in detail in new Folder 2648. The text describes advantages of the improved design in attaining: uniform influent distribution across the tank; uniform flow throughout entire tank length; and, uniform effluent discharge from surface.—Link-Belt Company.

1248

Steel Reservoirs and Standpipes—A 20-page bulletin on Horton Steel Reservoirs and Standpipes. Illustrations show installations from 150,000 to 6,000,000 gal. capacity with cone, umbrella, or ellipsoidal roofs and ornamental structures with special architectural features. Also included are: table of standard capacities, information on foundation, advantage of pickling and paintings, and data on the use of suction tank for fire protection.—Chicago Bridge & Iron Co.

1249

Valves, Sewage and Waste—Solid wedge gate valves, Class A, B, and C, maximum flow efficiency with valve operation unhampered by accumulated solids or silt. Circular No. 24.—M & H Valve & Fittings Co.

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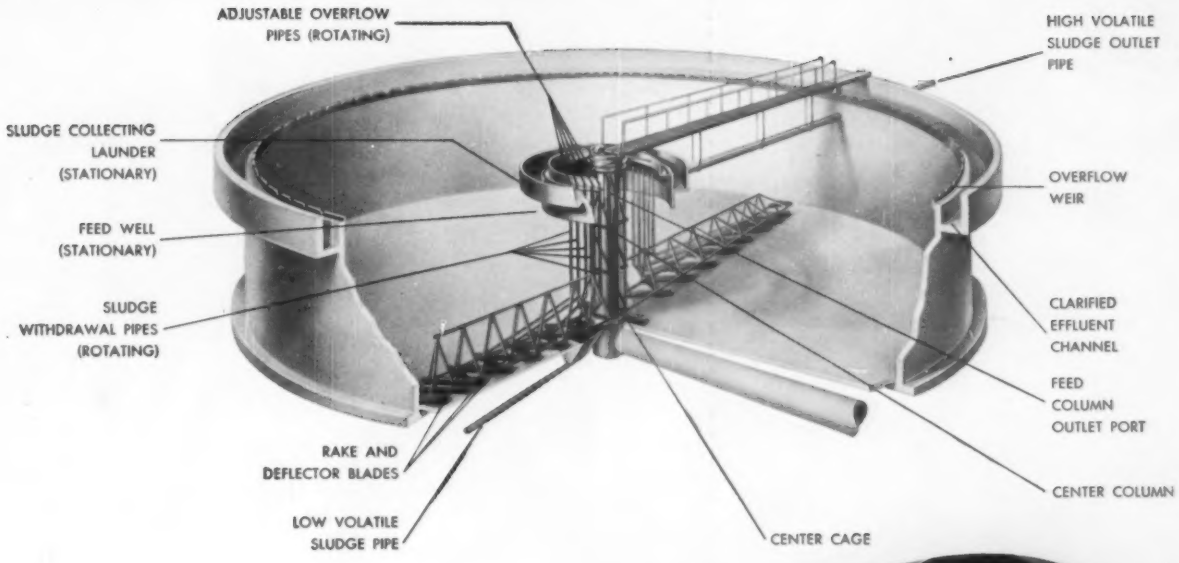

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